Investigations of Some Clay Deposits in Washington and Idaho

GEOLOGICAL SURVEY BULLETIN 1091

Prepared in cooperation with the United States Bureau of Mines

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By JOHN W. HOSTERMAN, VERNON E. SCHEID, VICTOR T. ALLEN, *and* I. G. SOHN

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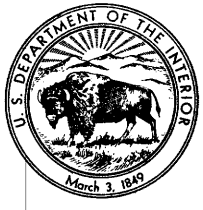

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INVESTIGATIONS OF SOME CLAY DEPOSITS IN PARTS OF WASHINGTON AND IDAHO

By JOHN W. HOSTERMAN, VERNON E. SCHEID, VICTOR T. ALLEN, and I. G. SOHN

ABSTRACT

The investigation of clay resources, made jointly with the U.S. Bureau of Mines 1942–1947, began as a part of a general investigation of possible sources of aluminum in the United States. It was undertaken as a precaution against the depletion of aluminum reserves, owing to the greatly increasing demand for aluminum during World War II.

The clay deposits of eastern Washington and northern Idaho, known as the Palouse hills, are at the eastern edge of the Columbia Plateau physiographic province. Three types of clay occur in the area: residual clay derived from the Columbia River basalt of Tertiary age; residual clay derived from the granodiorite and related intrusive rocks of the Idaho batholith of Late Jurassic or Cretaceous age; and transported clay, an erosional product of the dranodiorite and related intrusive rocks, deposited as part of the Latah formation of Tertiary age. The two types of residual clay were formed during an interval of weathering called the "Excelsior weathering period" that occurred between flows of the Columbia River basalt, when the land surface had a low to moderate relief and the climate was warm and humid with good oxidation conditions.

The mineral composition of a few samples have been studied in detail. X-ray and differential thermal determinations on these clays show that kaolinite and halloysite (hydrated) are the principal clay minerals. The residual clay derived from basalt is composed of white halloysite commonly colored blue, gray, or black by ilmenite and occasionally stained brown by limonite or green from nontronite. The residual clay derived from granodiorite and related intrusive rocks contains both halloysite and kaolinite, and the transported clay is predominantly kaolinitic. The latter two types of clay are very similar in physical appearance; both are white and both contain abundant quartz grains and mica flakes—but the residual clay retains a relict granitic texture and is not bedded.

It is estimated that about 300,000 tons (dry) of clay containing more than 20 percent available alumina occurs in eastern Washington and northern Idaho. About 90 percent of this tonnage is in four major deposits in Latah County, Idaho: Bovill clay deposit, Olson high-alumina clay deposit, Canfield-Rogers clay deposits, and Benson clay deposit.

INTRODUCTION

During World War II, the U.S. Geological Survey, in cooperation with the U.S. Bureau of Mines, made an appraisal of the alumina resources in an attempt to locate an adequate domestic supply of

aluminum. The demand for aluminum had increased enormously with the expanded production of war materials, but the domestic bauxite reserves were being depleted rapidly, and the importation of foreign bauxite was handicapped by transportation difficulties. As a part of this appraisal, high-alumina clay deposits in the northwestern States were investigated, some in considerable detail.

The primary objective of the appraisal was to obtain information on the possible usefulness of clay as a raw material in aluminum production; a related result was the data obtained on the ceramic properties of the clay deposits. This report contains the detailed results of geologic mapping, drilling, sampling, and analyses of seven clay deposits (Stockton, Canfield-Rogers, Olson, Stanford, Deary, Bovill, and Excelsior) in eastern Washington and northern Idaho.

The fieldwork was begun by V. E. Scheid during the summer of 1942, and was carried on until the summer of 1947. I. G. Sohn assisted Scheid in the field from June 1943 until August 1945. V. T. Allen did some of the mineralogic work and identified the relatively rare clay mineral, nontronite, in these deposits. The report was written and the illustrations and drill-hole logs were compiled by J. W. Hosterman from field maps and notes of Scheid and Sohn and the U.S. Bureau of Mines. The topographic Division, U.S. Geological Survey, compiled the topographic maps for the Excelsior, Olson, and Deary deposits.

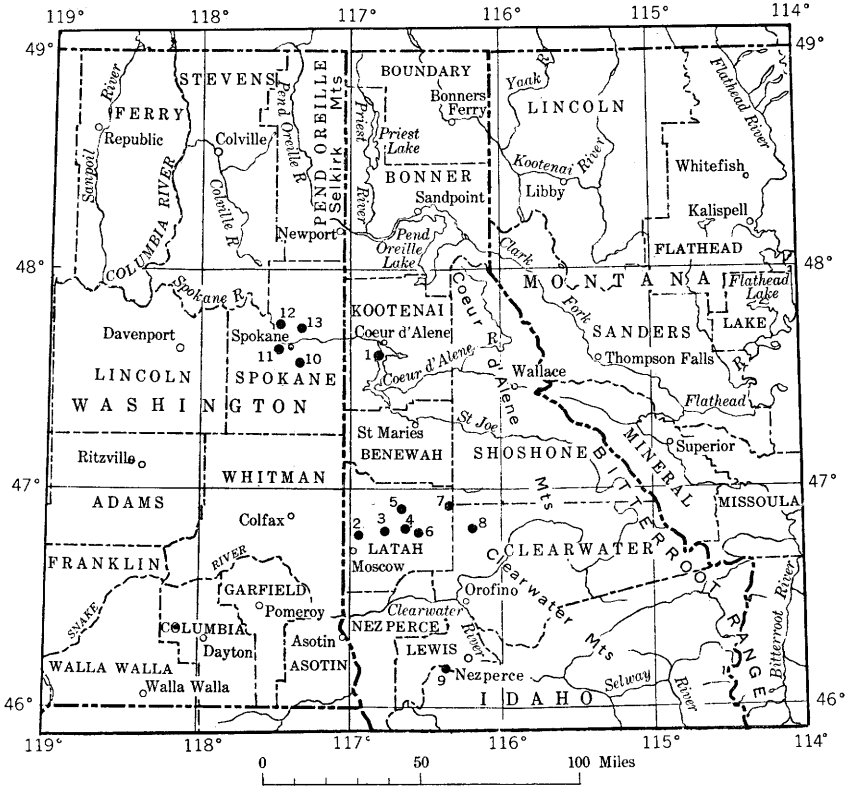
The U.S. Bureau of Mines started a drilling program in the fall of 1942 that continued uninterruptedly for 1 year. The drilling was begun again in the winter of 1944–45. R. H. Storch and Miro Mihelich were the engineers in charge of drilling. Approximately 567 hand-auger holes and 83 machine-drilled holes were drilled totaling about 20. 252 feet. The hand drilling was done with a 3-inch post auger of the Iwan type, with 5-foot lengths of 1-inch pipe for extensions. The machine drilling was done by a drivepipe method using a churn drill mounted on a truck chassis. Samples were taken at approximately 5-foot intervals or where the clay showed a marked change. Logs of the drill cores are on pages 40–146. Weighted composite samples (mixture of a number of individual samples) representing the minable thickness of clay in each hole were analyzed for total and available alumina, total and available ferric oxide, titania, and silica. Approximately 3,210 samples were dried at room temperature and sent to the U.S. Bureau of Mines laboratory, Seattle, Wash., for assaying. Results of the assays are also on pages 40–146.

The authors acknowledge the permission of the U.S. Bureau of Mines to publish the sampling and other exploration data. They are indebted to P. E. Oscarson and S. H. Lorain, district engineers

of the Bureau, for the many courtesies extended. Mr. A. W. Fahrenwald, former director, Idaho Bureau of Mines and Geology, kindly gave permission to use unpublished results of ceramic tests and field data. The authors thank the University of Idaho for the use of office space while preparing parts of this report.

GEOGRAPHIC SETTING

The clay deposits of eastern Washington and northern Idaho (fig. 1) are on the eastern edge of the Columbia Plateau physiographic province in the Palouse hills (Fenneman, 1931, p. 253), an area of broad, gently rounded hills and fairly broad even-floored valleys.



LIST OF DEPOSITS

IDAHO

Stockton and Stanley Hill 1
Canfield-Rogers 2
Benson 3
Olson 4
Stanford 5
Deary 6
Bovill 7
Elk River 8
Camas Prairie 9

WASHINGTON

Excelsior 10
Manito-Saxby 11
Fivemile Prairie 12
Deadman Creek 13

FIGURE 1.—Index map of the clay deposits in eastern Washington and northern Idaho.

The Palouse hills are bounded on the east by the Coeur d'Alene Mountains, part of the Bitterroot Range, on the south by the Snake River, and on the west and north by the Columbia and Spokane Rivers. In this area are the 7 high-alumina clay deposits that were mapped in detail and 6 clay deposits that were examined briefly. Some of the clay deposits in Latah County, Idaho, partly surround the Palouse Range.

GEOLOGY

GENERAL FEATURES

The oldest rocks of the region are argillaceous and arenaceous sediments of the Belt series of the Precambrian. They are overlain unconformably by volcanic flows of Permian(?) age. In Late Jurassic or Cretaceous time, the older rocks were intruded by large masses of granodiorite and related intrusive rocks that are considered to be a part of the Idaho batholith, which occupies almost all of central Idaho.

Beginning in Miocene time, the lava of the Columbia River basalt was extruded as many separate flows that dammed streams and formed lakes in which the Latah formation was deposited (Kirkham and Johnson, 1929, p. 500). The Latah formation, therefore, is interbedded with and contemporaneous with the Columbia River basalt. During a protracted lull in the extrusion of the basalt, an interval of weathering, termed the Excelsior weathering period, named from the Excelsior clay deposit, became the dominant process that caused the development of residual clay that divides the Columbia River basalt into two parts (Scheid, 1945, p. 9). During the Excelsior weathering period the climate was very warm and humid, with conditions that permitted complete oxidation of the surface rocks on a land surface of low to moderate relief. The results of other intraflow intervals of weathering have been observed, but none have residual clay that approaches the 124-foot maximum thickness or the lateral extent of the Excelsior weathering period (Scheid, 1947, p. 1224). Drilling has disclosed that the top of the weathering profile has nearly a plane surface beneath the hills and does not rise far above the present valley floors. Its exact lateral extent is not known because it is buried beneath later basalt flows to the west. There are, however, many occurrences of residual clay derived from basalt throughout the Palouse hills that were probably formed during the Excelsior weathering period. If the weathering period was active in the mountainous area to the east, evidence of it has since been removed by erosion except on the lower western slopes, where it may have been lightly covered by later basalt flows.

Renewed extrusion of the basalt flows brought the Excelsior weathering period to an end. The upper part of the Latah formation was deposited on the residual clays in lakes that were formed once more by streams dammed by the upper flows of the Columbia River basalt. This part of the Latah formation contains the principal transported clay deposits of the Palouse hills. When the extrusion of the basalt flows ceased, erosion once more became the dominant process in the region.

Toward the end of Pliocene time, diastrophism resulted in the downwarp of the central part of the Columbia Plateau and the uplift of the Cascade Range. This diastrophism initiated the present drainage system and canyon cutting and produced a gently sloping surface of basalt that dips southwestward. Early in Pleistocene time the aeolian material of the Palouse formation was deposited. Subsequently glaciers formed in the mountainous areas to the east and north, and much of the Palouse formation was removed from the valleys by glacial melt water.

FORMATIONS

BELT SERIES

The Belt series of the Precambrian is near the clay deposits in Latah County, Idaho, as steptoes—(hills or mountains of older rock completely surrounded by younger lava flows)—like the Kamiak Mountains in Washington (pl. 1)—and in the Coeur d'Alene Mountains to the east of the Excelsior high-alumina clay deposit (fig. 1). The rocks of the Belt series in this part of northern Idaho have been metamorphosed by the Idaho batholith and related intrusive rocks. They consist predominantly of quartzite, mica schist, and granite gneiss. The quartzite is in beds of medium thickness, light to medium gray, and fine to medium grained with numerous argillaceous partings. Quartz and sericite are the major constituents with very minor amounts of feldspar, biotite, tourmaline, zircon, and magnetite. The mica schist is medium gray, fine to medium grained, and composed chiefly of quartz, muscovite, and biotite. The granite gneiss is composed of quartz, muscovite, biotite, and both potash and soda-lime feldspars. Minor amounts of hornblende and pyroxene are also in the gneiss. All the rocks of the Belt series have been considerably folded and faulted. They have contributed very little other than quartz and mica to the transported clay deposits.

VOLCANIC ROCKS AT POTATO HILL

Volcanic rocks form Potato Hill (pl. 1) and its adjacent foothills immediately north of Deary, Idaho, and two small areas near Bovill,

Idaho. Tullis (1944, p. 140) tentatively considers them to be of Permian age, a suggestion that is followed in this report. In a railroad cut 1 mile east of Deary, xenoliths of granodiorite have been discovered in the volcanic rocks, and if the granodiorite is of Cretaceous age the Permian dating of the volcanic rocks is in error.

Two types of volcanic rocks are recognized at Potato Hill; porphyritic lava, 200 to 300 feet thick, and flow breccia, estimated to be 950 feet thick. The porphyritic lava is pink, gray, and dark purple, and varies in composition from rhyolite to dacite. The phenocrysts, which total about 6 percent of the rock, are orthoclase, plagioclase (Ab_{70}), quartz, and magnetite. The groundmass, originally hypohyaline, has been devitrified. The flow breccia, which is purple to black and spotted with light-colored inclusions, forms the bulk of the volcanic rocks at Potato Hill and appears to overlie the porphyritic lava. The inclusions are fragments of breccia and of sedimentary and igneous rocks in a cryptocrystolline groundmass. The volcanic rocks at Potato Hill have contributed no material to the transported clay deposits of the area.

GRANODIORITE AND RELATED INTRUSIVE ROCKS

Granodiorite and related intrusive rocks occur throughout the eastern part of the area. They are classified as part of the Idaho batholith, which is considered to be Late Jurassic or Cretaceous in age. Larsen states (Faul, 1954, p. 82 and 266) that the lead-alpha age determinations strongly suggest that the Idaho batholith and the southern California batholith, which is of Middle Cretaceous age, are parts of a single body.

In Latah County, Idaho, granodiorite predominates over small amounts of quartz-monzonite, tonalite, granite, and quartz-free syenite. The typical granodiorite is light gray, medium grained, and granular (locally gneissic or porphyritic). The abundant minerals are quartz, microcline, some orthoclase, albite, biotite, and hornblende; the accessory minerals are garnet, epidote, magnetite, apatite, zircon, and muscovite.

The stock at Gold Hill (pl. 1) is gray hornblende syenite, with equigranular texture. In it the most abundant minerals are microcline, oligoclase, and hornblende; magnetite, sphene, apatite, and augite are present in minor amounts.

The weathering and decomposition of these igneous rocks supplied much of the clay, sand, and gravel of the transported clay deposits. These rocks are also the parent rocks of the residual clay that is being mined at the Benson clay deposit, 3 miles northeast of Troy, Idaho (p. 1).

COLUMBIA RIVER BASALT

Although the Columbia River basalt may range in age from Miocene to Pliocene, it is considered to be the product of many closely related eruptions and is classed as one formation. The thickness of the basalt ranges from several feet at the flanks of steptoes and embayments along the eastern margin of the Columbia Plateau to more than a mile near the center, where subsidence was greatest (Baldwin, 1950, p. 60). In the vicinity of the clay deposits the residual clay formed during the Excelsior weathering period serves as a convenient marker to subdivide the formation into upper and lower basalt flows. In the field, the upper and lower basalt flows appear to be similar lithologically, and where the residual clay is not exposed, it is impossible to differentiate the flows. As seen under the microscope, however, the lower basalt is usually somewhat decomposed while the upper basalt is relatively fresh.

The Columbia River basalt consists of massive flows, vesicular lava, volcanic breccia, and pillow lava. Typically it is glassy to holocrystalline, dense, gray or blue-gray, or black basalt. Two kinds of basaltic glass, tachylyte and sideromelane, may be present (Peacock and Fuller, 1928, p. 361): tachylyte, the more common, is high in ferric iron and is a product of slow cooling; sideromelane is low in ferric iron and is a product of rapid cooling in water. Minerals in the basalt are: plagioclase, usually unzoned labradorite that makes up between 45 and 75 percent of the rock; pyroxene, usually reported as augite but believed to be pigeonite by Campbell (1950, p. 76), which makes up 40 percent or less of the rock; olivine, in very small amounts; and apatite, magnetite, and ilmenite that make up the accessories. Zeolites in amygdules are widespread. Silicate, carbonate, and iron hydroxide minerals are found on the walls of vesicles or as solid amygdules.

The rounded masses of pillow lava are from 1 to 6 feet in diameter and have a glassy coating, half an inch thick, over a dense or vesicular interior of gray or black with plagioclase phenocrysts arranged in a subtriangular texture in many places. The exterior of the pillows is buff to yellow; sedimentary material commonly fills the space between the pillows.

LATAH FORMATION

The age of the Latah formation is considered to be middle or upper Miocene. Although the formation was defined by Pardee and Bryan (1926, p. 7) as essentially one deposited before the extrusion of basalt, Kirkham and Johnson (1929, p. 499) defined the formation in Idaho as sedimentary material interbedded with the flows of the Columbia River basalt. In the general vicinity of the clay deposits, the Latah formation is interbedded with the Columbia River basalt, and it is

divided into an upper and lower part by the unit of basalt on which residual clay developed. Although the upper and lower parts of the Latah formation have similar lithologic characteristics, the upper part rests upon residual clay derived from basalt whereas the lower part rests upon unweathered basalt.

The Latah formation consists of unconsolidated lacustrine and fluvial sediments derived from the weathering and erosion of granodiorite and related intrusive rocks in the mountainous areas to the east. The sediments are light gray generally, white or yellow in some places, and red in a few places. They are predominantly kaolinite clay, with minor amounts of quartz gravel, quartz and feldspar sand, and muscovite flakes. The sand and gravel are not distributed randomly throughout the clay but are in separate beds. The greatest thickness of the lower part of the Latah formation penetrated by drilling was 43 feet (Ol–226, p. 113) and of the upper part, 121 feet (Ol–67, p. 82).

PALOUSE FORMATION

The Palouse formation of Pleistocene age corresponds to what Bryan (1927, p. 44) calls the inner core of the Palouse Hills. At places the formation is more than 250 feet thick (Treasher, 1925, p. 469); the greatest thickness found by drilling was 59 feet (E–46, p. 50), and the average is about 10 feet. Because of erosion, the formation is now thicker on the hills than in the valleys.

The Palouse formation is composed of massive, slightly stratified, brown and reddish-brown silt-size material. It has irregular, vertical columnar jointing as seen in high vertical road cuts. In many places, the base of the formation consists of granitic sand and gravel beds as much as 10 feet thick, whereas at other places the base consists of basalt gravel mixed with silt. A characteristic of the formation is its competency to maintain vertical faces in road cuts and stream cuts for many years. The Palouse formation antedates all glaciation in the area, and the major part of the formation has long been considered to have been deposited by wind, which obtained the material from a source to the west.

CLAY DEPOSITS IN THE PALOUSE HILLS AREA

MINERAL COMPOSITION

The mineral composition of the clay was determined microscopically by V. T. Allen during the time of the field investigations (1942–47). A few samples were identified with an X-ray spectrogoniometer using copper Kα radiation with a nickel filter. In the clay deposit of the Palouse hills, kaolinite, halloysite (hydrated), and nontronite are the clay minerals that have been identified. Kaolinite and halloysite are

the predominant clay minerals and both are equally important for their alumina content and refractory properties.

Kaolinite has a structural formula of $(OH)_8Al_4Si_4O_{10}$ and a theoretical composition of 46.45 percent SiO_2, 39.50 percent Al_2O_3, and 13.96 percent H_2O. The kaolinite structure is composed of a single silica tetrahedral sheet and a single alumina octahedral sheet joined together so that the oxygen tips of the tetrahedral sheet and one layer of the octahedral sheet form a common layer. If the bonds between the atoms and sheets are weak or if there is a slight substitution of titanium for the aluminum atom, thereby warping the octahedral sheet, then the structure of the kaolinite is poorly crystalline. The kaolinite in the clay deposits of the Palouse hills area is of the poorly crystalline variety, and it has a basal (001) spacing on the X-ray diffraction traces of 7.2A.

There are two forms of halloysite, one with a structural formula and theoretical composition the same as kaolinite, and the other with a structural formula of $(OH)_8Al_4Si_4O_{10}.4H_2O$ and a theoretical composition of 40.79 percent SiO_2, 34.55 percent Al_2O_3, and 24.66 percent H_2O. The latter form, sometimes called endellite, dehydrates irreversibly to the former at relatively low temperatures. Halloysite has the same structure as kaolinite, having about a 7.2A basal (001) spacing when dehydrated and a basal spacing of 10.1A when hydrated. The 2.9A difference is about the same thickness as a single molecular sheet of water. It is evident from this that differentiating between dehydrated halloysite and kaolinite by X-ray methods may sometimes be questionable. However, in the samples containing both halloysite and kaolinite, the halloysite was found to be finer grained than the kaolinite. Furthermore, it is evident that both the hydrated and dehydrated varieties of halloysite have approximately the same grain size within a given sample. These facts and X-ray diffraction traces indicate that there was probably no dehydrated halloysite present in any of the clay samples before they were collected.

It is significant, according to Sand (1956, p. 38) that no dehydrated halloysite occurs with the hydrated halloysite. This indicates that the conditions favorable for the formation of the hydrated halloysite has not changed since the Excelsior weathering period. Electron-microscope studies by Bates and his associates (1950, p. 463–489) show that halloysite occurs as modified tubes and kaolinite occurs as pseudohexagonal plates. Bates concluded that there is no apparent morphological transition between kaolinite and halloysite, hydrated or dehydrated.

Nontronite has a theoretical formula of $Fe^{+3}_{2.17}(Al_{0.83}Si_{3.17})O_{10}(OH)_2$ and a theoretical composition of SiO_2, 44 percent; Al_2O_3, 9 percent; Fe_2O_3, 27 percent; and H_2O, 20 percent. The nontronite is a massive

waxy yellowish-green clay. Its only importance is that it is a relatively rare clay mineral throughout most of the world. Eastern Washington and northern Idaho have become an important area for collecting specimens.

SIGNIFICANCE OF CHEMICAL DATA

The significant constituents for which the clay samples were analyzed by the U.S. Bureau of Mines include alumina (Al_2O_3), iron oxide (Fe_2O_3), titania (TiO_2), and silica (SiO_2). These, plus ignition loss, give a measure of the purity of a clay deposit and indicate its potential usefulness.

Alumina may be present in various clay minerals and aluminum oxides in a clay deposit, or it may still be locked in unweathered feldspar, mica, amphibole, and pyroxene minerals. Only the alumina in the clay minerals kaolinite and halloysite is useful for ceramic purposes and only the alumina that may be easily extracted from the clay minerals by chemical means is of value as raw material in the aluminum industry; this is "available alumina." Available alumina is defined by Skinner and Kelly (1949, p. 6) as the amount of alumina extracted from clay that has been dried at 130° C overnight, weighed, calcined at 700° C for 1 hour, and boiled in a 20 percent solution of sulfuric acid for 1 hour.

The relation of available alumina to total alumina in selected samples has been studied by Pask and Davies (1943, p. 14). They concluded that in minerals of the kaolin group, excluding dickite, 95 to 100 percent of the total alumina was available; in dickite (none found in the clay deposit of the Palouse hills area) about 65 percent was available; in the montmorillonite group, which includes nontronite, 20 to 30 percent of the total alumina was available. Inasmuch as the overwhelmingly dominant clay minerals in the Palouse hills clay deposits are kaolinite and halloysite, the analyses for available alumina are essentially a direct measure of the amount of kaolin minerals and thus of the probable usefulness of the deposit for aluminum production.

The ferric oxide (Fe_2O_3) in a clay deposit may be locked in unweathered pyroxene, amphibole, biotite, magnetite, and ilmenite, but it may also be in such weathering products as goethite, hematite, limonite, and iron-bearing clay minerals such as nontronite. Therefore, some of the total ferric oxide is available. By definition, available ferric oxide is the percentage by weight of the ferric oxide in the calcined clay that is soluble in a 20 percent solution of sulfuric acid after boiling for 1 hour. Available ferric oxide is undesirable in a high-

alumina clay deposit because it will adversely affect both the extractability of the alumina and the refractory properties. In general, the good drainage conditions that help to produce kaolinite flush out the iron oxides. The iron oxides in residual clay deposits usually increase with depth as weathering effects become less pronounced.

The titania (TiO_2) content of a clay deposit is largely dependent upon the amount of ilmenite that is in the clay. Ilmenite is not readily soluble in a 20 percent solution of hot sulfuric acid, and thus most of the titania is unavailable. Therefore, the presence of titania will not affect the extractability of alumina, but it may influence considerably the ceramic properties of the clay.

Loss on ignition (the sample is weighed, calcined at 700° C to a constant weight) of a clay sample is due to the escape of moisture, organic matter, and CO_2 that may be present. In general, one would not expect a precise correlation between ignition loss and clay content unless the clay sample is unusually pure. For some of the deposits studied in the Palouse hills area, such a correlation seems to exist (see table 1).

TYPES OF CLAY

The high-alumina deposits of the Palouse hills contain three types of clay: residual clay derived from basalt; residual clay derived from granodiorite and related intrusive rocks; and transported clay (in the Latah formation). A single deposit may contain one, two, or all three types. Recognition of these types of clay and knowledge of their chemical composition may be helpful in evaluating, developing, and extending the present deposits. With this in mind, the three types were examined in detail, and the chemical data obtained from the U.S. Bureau of Mines are summarized on tables 1, 2, 3, and 4.

RESIDUAL CLAY DERIVED FROM BASALT

The best grade residual clay derived from basalt is composed of residual hydrated halloysite and transported kaolinite and hydrated halloysite with scattered grains of ilmenite. The transported kaolinite is predominantly from the overlying Latah formation, and the transported halloysite is derived from the basalt and redeposited by ground water. The uniformly disseminated grains of blue-black ilmenite against the white halloysite accent the commonly indistinct relict basalt texture. The residual clay is the result of intense weathering of the lower flows of the Columbia River basalt, associated pillow lava, and breccia during the Excelsior weathering period, when the climate was humid and relatively warm (Berry, 1929, p. 233). The clay deposits were formed on a land surface of low to moderate relief

where good internal drainage conditions permitted complete oxidation (Scheid, 1947).

Most of the Columbia River basalt is vesicular, and all the flows are cut by numerous joints; thus during the Excelsior weathering period, water entered these joints but could not move freely at first. As the basalt weathered, the permeability and the porosity increased, and the internal drainage improved, permitting the complete oxidation that produced halloysite (Allen and Scheid, 1946, p. 309). Had the poor drainage conditions and lack of oxidation persisted, montmorillonite and nontronite would probably have formed instead, according to the observations of Hoskins (1940, p. 206). In places where poor drainage conditions did continue to exist and where there were alkalies present, the basaltic glass of the tuff and breccia was probably altered to palagonite that in turn altered to nontronite. Residual clay derived from basalt in the southern half of the Olson deposit (high-iron clay deposit), for an example, contains a high percentage of ferric oxide, largely in nontronite, probably because the clay formed here was in an area of very poor drainage. In areas where the drainage conditions improved, the early-formed nontronite was removed by solutions and redeposited in cracks and vesicles in the fresh and semidecomposed basalt at depth. Near the surface, the orthoclase and plagioclase feldspar, glass pumice fragments, and groundmass of the basalt altered directly to halloysite, and the iron oxides were reduced to the ferrous state by slightly acid solutions. The openings left by the nontronite were filled with kaolinite carried in colloidal solution from the overlying Latah formation or with halloysite forced in by compaction of the residual clay. Residual ilmenite and very fine grained quartz remained essentially unaltered, and they were somewhat concentrated by the weathering and erosion processes.

The chemical changes that have occurred in the alteration of basalt to residual clay are illustrated in the following table. The quantity of silica in the clay depends upon the degree of weathering of the source rock. In general, more complete weathering produces a higher content of clay minerals and a lower content of silica.

In most deposits, five subparallel gradational zones can be distinguished from the top of the residual clay downward to fresh basalt. They are: high-grade alumina clay, intermediate-grade alumina clay, low-grade alumina clay, semidecomposed basalt, and fresh basalt. This can be best exemplified from the averages of six drill holes (E–16, p. 44 and 25, p. 46; M–39, p. 55; 47, p. 57; 49, p. 57; and 78, p. 62) of the Excelsior high-alumina clay deposit.

Chemical analyses showing changes produced by the weathering of basalt to residual clay

	A	B	C
SiO_2	52.31	40.3	41.2
Al_2O_3	14.38	30.8	31.1
Fe_2O_3	2.47	9.1	8.2
FeO	9.95		
MgO	4.46	.0	.0
CaO	8.37	1.0	1.0
Na_2O	2.94	.5	.4
K_2O	1.26	.4	.3
TiO_2	2.10	7.5	7.3
P_2O_5	.36		
V_2O_5		.05	<.05
MnO	.21		
H_2O-	.39		
H_2O+	.74	[1] 10.9	[1] 11.1
Total	99.94	100.5	100.6

[1] Total ignition loss.

NOTE: Source of samples.
A. Average of thirteen samples of Columbia River basalt (Waters, 1955, p. 705).
B. Residual clay derived from basalt, area 1, Excelsior clay deposit. Analyses by the U.S. Bureau of Mines, Northwest Experiment Station, Seattle, Wash.
C. Residual clay derived from basalt, area 2, Excelsior clay deposit. Analyses by the U.S. Bureau of Mines, Northwest Experiment Station, Seattle, Wash.

The zone of high-grade alumina clay is composed almost entirely of halloysite and unaltered ilmenite, and the clay is plastic. The clay is stained blue and bluish black from ilmenite. The upper part of the zone in many places is stained yellow in spots and streaks by limonite derived from the slow decomposition of ilmenite. The residual clay derived from basalt in this zone averages 31 percent available alumina and 3 percent available iron oxide. In many deposits the available alumina increases and the available iron oxide decreases from the top of the residual clay to a depth of 8 to 10 feet (fig. 2). At this depth, the available alumina begins to decrease and the available iron oxide begins to increase with additional depth until they equal the amounts found in fresh basalt.

The intermediate-grade alumina-clay zone is composed of halloysite, unaltered ilmenite, and some nontronite and limonite. The clay deposits are generally gray or brown from ilmenite or limonite and may have a green hue from nontronite. Where these clays have been derived from vesicular basalt, most of the vesicles and openings are filled with transported kaolinite, and a few are filled with transported nontronite. The residual clay in this zone averages about 27 to 28 percent available alumina and 4 to 5 percent available iron oxide.

The zone of low-grade alumina clay is composed of halloysite, ilmenite, nontronite, and limonite. The clay deposits are dark shades of gray, blue, green, and brown. This zone is distinctly harder than those above it, and the brown color is due to large quantities of

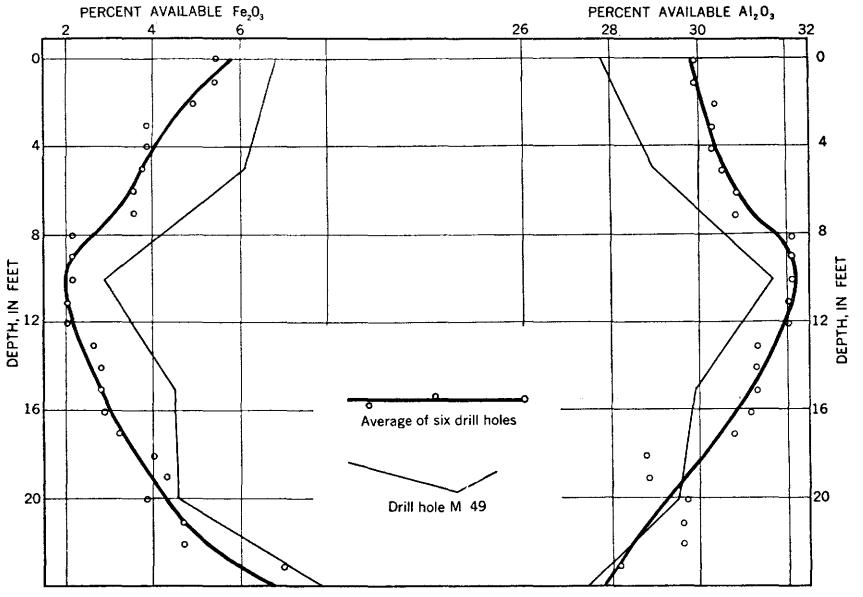


FIGURE 2.—Variation of available Al_2O_3 and Fe_2O_3 with depth in the high-grade alumina-clay zone of the residual clay derived from basalt, Excelsior high-alumina clay deposit, Spokane County, Wash.

limonite. Most of the vesicles and openings are filled with transported nontronite, but a few are filled with transported halloysite. Grains of residual nontronite were noted in this zone. The residual clay in this zone averages about 23 percent available alumina and 13 percent available iron oxide.

The low-grade clay zone changes abruptly into the underlying semidecomposed basalt, which contains unaltered original minerals, grains of residual nontronite, and sparse residual halloysite. Transported nontronite fills some of the vesicles and openings; the rest are unfilled. This zone contains an average of about 13 percent available alumina and 7 percent available iron oxide.

The fresh rock is hard unaltered basalt; a few residual nontronite specks may be seen, and the openings in the basalt are unfilled.

Minerals other than halloysite, kaolinite, ilmenite, nontronite, and limonite have been found in small quantities in the residual clay derived from basalt. Small quantities of very fine grained quartz were found in all the residual clay samples, and feldspar was found in the bottom of drill hole D–18 where the basalt is incompletely decomposed. Small amounts of quartz and muscovite from the overlying Latah formation have been found filling cracks and vesicles in the upper part of the residual clay.

The thickness of the residual clay derived from basalt averages about 10 feet in the Palouse hills area, but in the southern half of

the Olson deposit (the clay deposit with high content of iron), the residual clay averaged about 80 feet, and in drill hole Ol–226 (see p. 118) clay 123.6 feet thick was found. Determinations of specific gravity on the residual clay derived from basalt ranged from 1.51 to 1.84 and averaged 1.64. The moisture content ranged from 22.4 to 39.6 percent and averaged 33.7 percent.

Table 1 gives significant chemical data on 28 composite samples of residual clay derived from basalt from the Excelsior and Olson deposits. Fifteen samples of residual clay were also assayed for gallium, which ranged from 0.003 to 0.006 percent (see drill holes D–2, p. 67; D–18, p. 70; Ol–126, p. 93; Ol–164, p. 101; and Ol–193, p. 107).

TABLE 1.—*Chemical data for residual clay derived from basalt*

[From U.S. Bureau of Mines analyses of weighted composite samples made for the total clay thickness of each hole.]

Drill-hole No.	Feet in sample	Interval (feet)	Ignition loss 950° C	Total SiO_2	Total Al_2O_3	Total Fe_2O_3	Total TiO_2	Ignition loss 700°C	Available Al_2O_3		Available Fe_2O_3	
									[1] 700° C.	Percent recovery	[1] 700° C.	Percent recovery
E–2[2]	22.0	58.0–80.0	10.6	39.7	28.2	13.4	6.9	10.6	27.5	97.5	9.6	71.6
–10	15.0	48.0–63.0	9.3	49.5	28.4	5.4	4.8	9.3	26.3	92.6	2.8	51.9
–14	10.0	43.5–53.5	11.9	39.4	34.4	5.8	8.4	11.8	33.1	96.2	1.0	17.2
–23	28.0	49.0–77.0	10.3	43.2	29.0	9.6	6.5	10.2	27.5	94.8	5.7	59.4
–25	15.5	35.0–50.5	11.3	39.4	33.7	7.8	7.0	11.3	31.8	94.4	3.2	41.0
–29	6.5	13.5–20.0	10.2	39.0	27.9	14.7	6.0	9.9	26.1	93.5	9.3	63.3
–34	28.0	13.0–41.0	11.3	38.3	31.0	11.4	7.0	11.1	29.5	95.2	7.5	65.8
–40	16.0	1.0–17.0	11.4	36.9	32.4	10.9	7.5	11.2	31.4	96.9	5,6	51.4
M–14[2]	17.0	7.5–24.5	10.8	41.3	29.2	12.3	6.0	10.5	28.6	97.9	3.6	29.3
–26B	9.0	9.0–18.0	8.6	43.5	24.8	13.0	6.2	11.5	24.0	96.8	5.4	41.5
–30	15.0	13.0–28.0	8.7	43.7	25.0	12.5	6.5	8.5	22.3	89.2	7.0	56.0
–39	31.0	5.0–36.0	11.3	40.0	32.2	9.1	6.3	11.2	30.6	95.0	4.9	53.8
–42	46.0	3.0–49.0	11.3	43.5	30.9	5.3	7.5	10.9	30.6	99.0	2.9	54.7
–44	32.0	12.0–44.0	11.4	40.5	32.4	7.1	7.8	10.9	31.6	97.5	3.1	43.7
–47	19.0	11.0–30.0	10.5	40.8	32.8	6.7	7.0	10.2	30.3	92.4	2.3	34.3
–50	7.0	2.0– 9.0	11.6	43.1	30.2	9.0	5.0	11.2	30.1	99.7	6.3	70.0
–65	24.0	17.0–41.0	10.4	39.9	29.2	11.5	6.3	10.3	27.9	95.5	6.8	59.1
–75	32.0	17.0–49.0	11.0	39.2	29.6	10.4	8.3	10.8	29.6	100.0	4.3	41.3
–77	13.0	5.0–18.0	8.7	47.1	22.8	12.7	5.8	7.9	21.9	96.1	9.9	78.0
Ol–58[3]	5.9	11.5–17.4	------	------	36.7	7.1	------	15.8	29.2	79.6	3.6	50.7
–66	5.7	45.0–50.7	------	------	37.3	11.2	------	15.0	27.5	73.7	5.4	48.2
–72	12.7	11.8–24.5	------	------	37.5	12.3	------	12.0	29.1	77.6	9.1	74.0
–111	18.0	20.0–38.0	8.5	58.4	24.3	6.0	2.4	7.9	22.0	90.5	4.4	73.3
–134	7.5	16.5–24.0	8.3	48.3	16.5	19.9	3.3	7.1	14.6	88.5	18.0	90.5
–163	8.3	18.7–27.0	10.2	48.5	29.6	5.5	4.1	10.0	27.3	92.2	4.2	76.4
–173	12.6	7.5–20.1	11.9	47.4	33.9	3.7	2.0	11.6	32.2	95.0	3.0	81.1
–207	27.3	10.5–37.8	11.0	42.1	30.4	10.1	5.6	10.6	29.0	95.4	7.1	70.3
–210	4.1	13.5–17.6	9.2	47.3	24.8	12.4	4.0	8.5	21.8	87.9	8.7	70.2
Average	------	------	10.6	42.4	30.1	9.4	6.4	10.6	28.5	94.7	5.4	57.4

[1] Because this table is based on composite samples, these assays may not agree with those listed for the same interval and drill hole in tables and the logs.
[2] Excelsior high-alumina clay deposit, Spokane County, Wash.
[3] Olson high-alumina clay deposit, Latah County, Idaho.

RESIDUAL CLAY DERIVED FROM GRANODIORITE AND RELATED INTRUSIVE ROCKS

Some residual clay is the result of intense weathering of granodiorite and, to a lesser extent, quartz monzonite, tonalite, granite, and syenite. These rock types occur in the fringe area of the Idaho batholith of Late Jurassic or Cretaceous age, and the residual clay is overlain by the Latah formation and (or) the Palouse formation. It is probably also overlain in places by the upper flows of the Columbia River basalt, but no drilling was deep enough to penetrate through the basalt to prove this. The original texture of the rock, whether granitoid, aplitic, pegmatitic, or gneissoid, is generally retained in the residual clay.

Exploratory drilling in the residual clay derived from granodiorite at the Benson deposit reached a depth of 100 feet without striking hard rock (Wilson and Goodspeed, 1934, p. 8).

Irregularities in the depth and lateral extent of the residual clays derived from granodiorite and related intrusive rocks depend on: the nature of the parent rock; the local structures controlling permeability; duration of the weathering interval; and irregularity of erosion prior to, contemporaneous with, and subsequent to the weathering. The residual clay that was formed at lower elevations makes up the present deposits of residual clay derived from granodiorite, while the clay that formed at higher elevations has been removed and is now part of the material that makes up the transported clay deposits of the Latah formation. Therefore, any zoning seen now in the residual clay may only be a part of the original zoning formed at the time of weathering. Some gradational zoning was noted, but data on variations in alumina and iron oxide content are not available. The upper zone, from the surface to about 50 feet deep, consists of kaolinite, hydrated halloysite, muscovite, and quartz, and there is no feldspar or biotite. The kaolinite-halloysite ratio varies considerably with depth in this zone. Near the top there is very little halloysite and toward the bottom of the zone kaolinite and halloysite are in roughly equal amounts. The second zone, from about 50 to 70 feet, contains increasingly more halloysite with very little kaolinite, muscovite, and quartz; also, a few scattered fresh feldspars were observed. The white to pink clay in this zone is stained yellow and brown from the iron oxides carried by descending solutions. The third zone, from about 70 to 100 feet below the top, consists, in the upper part, of muscovite and quartz with some hydrated halloysite. The amount of fresh feldspar and biotite increase markedly with depth in this zone.

According to the conclusions by Sand (1956, p. 39) on his study of the residual kaolin deposits in the southern Appalachian region,

hydrated halloysite is formed from feldspathic rocks low in mica, and kaolinite is formed from feldspathic rocks high in mica, if other environmental conditions are favorable for the formation of halloysite. This may explain why the halloysite content increases with depth in the Benson pit.

Table 2 contains significant chemical data on six composite samples of residual clay in the Olson deposit, Latah County, Idaho. Published analyses show that the total alumina content of the raw residual clay at the Benson clay deposit is about 20 percent (Tullis and Laney, 1933, p. 493; Hodge, 1938, p. 653). The alumina content, however, of the washed residual clay is very close to the theoretical maximum of 39.5 percent (Wilson and Goodspeed, 1934, p. 84). As a result of their washing tests, Wilson and Goodspeed report that the raw clay contains 30 to 40 percent kaolinite, 30 to 40 percent coarse-grained quartz, and 20 to 30 percent fine-grained quartz and mica.

TABLE 2.—*Chemical data for residual clay derived from granodiorite and related intrusive rocks*

[From U.S. Bureau of Mines analyses of weighted composite samples made for total clay thickness of each hole]

Drill-hole No.	Feet in sample	Interval (feet)	Ignition loss 1000°C	Total SiO_2	Total Al_2O_3	Total Fe_2O_3	Total TiO_2	Ignition loss 700°C	Available Al_2O_3		Available Fe_2O_3	
									700° C.[1]	Percent recovery	700° C.[1]	Percent recovery
Ol-82[2]	0.2	70.2- 70.4	------	------	17.3	3.7	------	4.5	9.7	56.1	0.7	18.9
-100	39.1	44.2- 83.3	------	------	28.7	4.5	------	8.5	22.4	78.0	3.0	66.7
-108	44.1	91.3-135.4	4.5	73.9	17.8	2.5	0.1	4.2	11.7	65.7	1.8	72.0
-109	0.2	107.0-107.2	------	------	27.5	3.2	------	8.8	21.0	76.5	2.7	84.3
-204.1	65.0	70.0-135.0	6.0	64.4	20.3	5.6	0.6	5.9	15.9	78.3	4.8	85.7
-206	46.2	68.0-114.2	6.3	69.9	19.7	2.6	0.3	6.2	17.5	88.8	2.0	76.9
Average	------	----------	5.7	68.7	21.3	4.0	0.4	6.1	16.6	77.9	3.1	77.5

[1] Because this table is based on composite samples, these assays may not agree with those listed for the same interval and drill hole in the logs.
[2] Olson high-alumina clay deposit, Latah County, Idaho.

TRANSPORTED CLAY

The transported clay deposits in the Palouse hills area are products of weathering and abrasion, and they have very little or no chemical additions. They are bedded deposits in the upper part of the Latah formation overlying residual clay. The transported clay is light gray or pink and stained or streaked yellow, brown, or red by iron oxides (limonite or hematite) in many places. The clay is plastic and has a very high content of kaolinite, but quartz silt and muscovite flakes occur in varying amounts. Interbedded with the transported clay are some zones of sandy clay, sand, and pebble beds. Samples of transported clay from the Rogers pit of the Canfield-Rogers clay

deposit, Latah County, Idaho, were analyzed on the X-ray spectrogoniometer and found to contain poorly crystalline kaolinite and muscovite in approximately a 3:2 ratio and a very small amount of quartz.

Representative columnar sections (pl. 2) of the Olson high-alumina clay deposit, Latah County, Idaho, pinkish-gray or gray plastic transported clay immediately above residual clay. This plastic clay seems to be the only unit that can be correlated throughout the deposit. Though it was not cut by drill hole Ol–136. Twelve drill holes show a zone that is high in available ferric oxide directly above the plastic clay and five drill holes show a zone high in available ferric oxide several feet above the plastic clay. Drill hole Ol–136 has no such zone because most of the transported clay has been removed by erosion. A zone low in available alumina is found in many places above the zone that is high in available ferric oxide. The percentage of available alumina in this zone is well below the 20 percent cutoff for a potential source of alumina, as shown by drill hole Ol–120.

Representative columnar sections of the Bovill deposit, Latah County, Idaho, (pl. 2) show that there is a zone of gray, pink-gray, or yellow plastic transported clay of high alumina content resting upon, or a few feet above, the residual clay derived from basalt. Above the plastic clay, there is a zone of yellow or gray sandy clay or sand of low available alumina. If these two zones are correlated with two zones of similar materials occurring between 21.7 and 41.5 feet of drill hole B–12 (see p. 66), the sample from 41.5 to 52.4 feet of drill hole B–12 is probably residual clay derived from granodiorite. From this information, it may be assumed that the first sedimentary material deposited after the Excelsior weathering period was plastic, high-alumina clay; however, the possibility that this material is the result of the reworking of the residual clay with transported clay cannot be ignored. Drill holes B–1, 2, and 6 (pl. 1*B* and p. 63-65) all end in pebble beds that may represent the same sand and sandy clay zone mentioned above; however, there is no correlative lithologic unit above these beds to prove this assumption.

Table 3 contains significant chemical data for 11 composite samples of transported clay from the Olson deposit. Much of the total silica content of these samples is a constituent of the clay minerals, but some is present as admixed quartz grains.

CHEMICAL COMPARISON OF THE THREE TYPES OF CLAY

Table 4 summarizes the average chemical properties of the residual clay derived from basalt from table 1, residual clay derived from granodiorite and related intrusive rocks from table 2, and transported clay from table 3.

TABLE 3.—*Chemical data for transported clay*

[From U.S. Bureau of Mines' moisture and composite samples]

Drill-hole	Feet in sample	Interval (feet)	Ignition loss 1000° C	Total SiO_2	Total Al_2O_3	Total Fe_2O_3	Total TiO_2	Ignition loss 700° C	Available Al_2O_3		Available Fe_2O_3	
									[1] 700° C.	Percent recovery	[1] 700° C.	Percent recovery
Ol-77 [2]	40.0	8.5–48.5	------	------	21.5	2.9	------	5.8	11.9	55.3	1.5	52.7
-105	35.6	7.4–43.0	10.1	57.3	25.7	4.4	1.0	9.3	23.3	90.7	3.9	88.6
-106	68.1	12.8–80.9	8.9	62.9	25.1	2.2	0.8	8.9	23.8	94.8	1.8	81.8
-109	77.3	19.3–96.6	10.7	50.3	28.0	8.9	1.4	10.3	26.9	96.1	8.1	91.0
-144	30.3	32.6–62.9	9.5	58.5	23.8	6.6	1.0	8.7	22.2	93.3	6.3	95.5
-146	49.6	5.4–55.0	8.6	62.0	23.2	4.7	0.9	8.4	22.5	97.0	3.8	80.9
-209	74.1	10.5–84.6	6.8	65.9	20.6	3.6	0.7	6.5	17.5	85.0	2.7	75.0
-275	17.3	12.0–29.3	10.5	55.1	29.1	3.0	0.8	10.1	26.9	92.4	2.2	73.3
-281	20.4	15.5–35.9	9.6	49.5	26.5	10.8	1.4	9.2	23.2	87.5	9.9	91.7
-290	10.1	35.6–45.7	9.2	58.4	26.5	3.2	1.0	9.0	23.8	89.8	2.4	75.0
-305	39.7	8.0–47.7	10.2	56.3	28.3	3.6	1.0	10.0	26.6	94.0	3.5	97.2
Average	------	----------	9.2	58.5	24.8	4.9	1.0	8.6	22.3	89.9	4.2	85.7

[1] Because this table is based on composite samples, these assays may not agree with those listed for the same interval and drill hole in the logs.
[2] Olson high-alumina clay deposit, Latah County, Idaho.

TABLE 4.—*Average chemical properties of the three types of clay*

	Residual clay derived from—		Transported clay (percent)
	Basalt (percent)	Granodiorite (percent)	
Ignition loss 700° C	10.6	6.1	8.6
Total Al_2O_3	30.1	21.3	24.8
Available Al_2O_3	28.5	16.6	22.3
Recovery Al_2O_3	94.9	77.9	89.9
Total Fe_2O_3	9.4	4.0	4.9
Available Fe_2O_3	5.4	3.1	4.2
Recovery Fe_2O_3	57.4	77.5	85.7
Total SiO_2	42.4	68.7	58.5
Total TiO_2	6.4	.4	1.0
Moisture at 130° C	29.0	14.0	24.0
Specific gravity (wet)	2.13	2.13	2.13

Table 4 clearly shows that the residual clay derived from basalt has a higher alumina content, and the percent recovery of the alumina is also greater. Undoubtedly the alumina content and its percent of recovery would have been higher in both the residual clay derived from granodiorite and the transported clay if they had been washed prior to assaying. Also because they were not washed, the silica content is much higher because of the free silica as grains of quartz. The much higher content of titania in the residual clay derived from basalt is quite understandable because the parent rock of this clay is the only one that contains any amount of ilmenite. Ilmenite also is responsible for the higher total iron oxide in the clay, and, as the

ilmenite is not appreciable soluble in sulfuric acid, most of the iron oxide is not available in the residual clay derived from basalt. The percentage of moisture for each type of clay was calculated on the basis of a constant dry weight at 130° C. Evidently, the residual clay derived from granodiorite was less porous and more compact and therefore held less water than the other two types of clay. An average of 2.13 was used for the specific gravity (wet) of all three types of clay when computing the reserves.

CLAY AS A RAW MATERIAL FOR ALUMINUM

During World War II, the U.S. Bureau of Mines and the War Production Board set up the following requirements for a clay deposit that was to serve as a source of alumina: the clay must contain at least 20 percent available alumina; and less than 5 percent available iron oxide; it must be at least 5 feet thick for economic mining; the overburden should be no more than three times the thickness of the clay; and the deposit should be located satisfactorily with reference to transportation facilities.

The metallurgic processes of extracting alumina from kaolin clays, as outlined by Popoff (1955, p. 29–34), have not been advanced far enough to determine the maximum permissible cost per ton of clay. It is agreed, however, that the method of mining must be one that will yield very large tonnages at low cost. The cheapest mining method would be strip mining, using dirt-moving equipment. Because of the rainy season, the strip mine floors would require a 4- to 7-percent grade for proper drainage and gravel roads for truck transportation.

Beneficiation by air or water separation would help to increase the available alumina content of all types of clay. It might also produce worthwhile products such as ilmenite from the residual clay derived from basalt and quartz sand from the residual clay derived from granodiorite and the transported clay. Another byproduct worth considering is gallium from the residual clay derived from basalt.

CLAY AS RAW MATERIAL FOR CERAMIC PRODUCTS

Grim (1939) has discussed the influence of the mineral composition on properties of unfired and fired clays. The montmorillonite and illite minerals have greater effect on the properties of unfired clay than the kaolin minerals. Plasticity, drying shrinkage, and bonding strength are high for the montmorillonite minerals, a little lower for the illite minerals, and much lower for the kaolin minerals. Any amount of the montmorillonite and (or) illite minerals in the kaolin clay deposits would change the physical properties of unfired clays to a marked degree. However, there seems to be very little or no montmorillonite or illite in the residual clay derived from granodiorite or transported clay. Nontronite is present in most of the residual clay

deposits derived from basalt; and, therefore, these deposits were not considered to be worth testing for ceramic properties.

The inflence of mineral composition on the properties of the fired clay is complicated by the presence of minor constituents and impurities. Some general relationships are evident; montmorillonite group and illite group—clay minerals that contain appreciable iron oxides—burn red or yellow. Kaolin group minerals burn white or light buff. The minerals of the montmorillonite group and the illite group contain potash, soda, or alkali earths either within the atomic lattice or as adsorbed ions. These impurities with or without associated iron oxide make the montmorillonitic and illitic clays generally nonrefractory. Kaolinite clay, on the other hand, contains little or no alkali or alkali earths; therefore, the residual clay derived from granodiorite and the transported clay in the deposits of the Palouse hills area should be satisfactory for refractory purposes.

The presence of appreciable amounts of iron, calcium, magnesium, sodium, and potassium will lower the temperature of fusion to the extent that even the kaolin clay will become nonrefractory. These elements that lower the temperature of fusion are called fluxing impurities or fluxes. In general, the refractoriness increases as the alumina increases and decreases as the iron oxide increases, but it does not follow that two samples of clay with the same alumina and iron oxide content will be equally refractory, because the fluxing impurities other than iron might be more abundant in one than the other.

Information published by Skeels (1920, p. 38) shows that there are many deposits of clay throughout Latah County, Idaho, suitable for most ceramic uses. Skinner and Kelly (1949, p. 37), furthermore, made many ceramic tests on a large number of samples of high-alumina transported clay from the Olson deposit. Many of the clay sampled at this deposit were shown to be suitable for intermediate heat duty (pyrometric cone equivalent, PCE, of 26 to 31) and high heat duty (PCE 31–33), while some were suitable for superheat duty (PCE 34). Judging from the work of Skinner and Kelly, nearly all transported clay containing more than 15 percent available alumina and not more than 5 percent available iron oxide is usable for many ceramic purposes.

Ceramic tests were made on samples of transported clay from the Olson and Deary clay deposits. Although the tests performed do not give the complete ceramic information, they are sufficient to show that the clay is excellent for ceramic structural wares. The color characteristics of 47 transported clay samples, both in the raw state and after being heated to 2,000° F, and the pyrometric cone equivalents are listed in the following table. The ignition loss and available iron oxide and alumina content are also listed so that the analyses of the clay can be compared with the pyrometric cone equivalent.

Ceramic tests on transported clays

[Clay samples from the Olson deposit (drill holes 01–126, 164, and 193) and the Deary deposit (drill holes D–2 and 18), Latah County, Idaho. Tests made for the U.S. Geological Survey by private companies]

Drill hole	Sample length (feet)	Raw color	Ignition loss	Available Fe_2O_3	Al_2O_3	Linear shrinkage		Firing color	PCE	Remarks
						Drying	Firing [1]			
01–126	24.5–29.5	yellow-buff	8.6	4.4	23.8	6.3	5.2		30	
	29.5–34.5	grayish-yellow	9.9	3.1	27.1	6.3	6.2	light buff	30+	
	34.5–39.5	buff	8.5	3.9	22.8	7.3	4.2	pink	29+	
	39.5–47.3	reddish-brown	6.3	4.7	16.8	5.2	1.6	light red	29	Considerable mica.
	47.3–51.3	buff	9.7	3.6	26.7	6.8	7.8	buff	32	
	51.3–55.5	dark buff	8.0	9.2	19.8	6.8	4.7	bright red	26	
	55.5–68.2	dark gray	11.8	2.7	31.9	7.8	16.7	light grayish-buff	32+	
164	41.5–43.9	light buff	6.3	2.6	16.1	4.7	2.1	light buff	30	High in quartz, good dry strength.
	43.9–44.5	buff	7.0	11.5	18.0	5.2	3.1	reddish-brown	26−	Do.
	44.5–47.9	light yellow	10.2	7.9	26.3	6.3	8.3	dark red-brown	30+	Good dry strength.
	47.9–51.7	yellow	11.4	14.0	27.6	6.3	18.2	reddish-brown	26	Poor dry strength.
	51.7–61.4	light gray	12.5	2.2	32.3	7.3	10.9	light buff	32+	Good dry strength.
193	12.7–14.2	red	8.9	5.4	23.9	7.3	6.2	red	28+	High dry strength.
	14.2–16.1	light red	8.5	4.0	23.0	7.3	5.2	salmon red	29+	Do.
	16.1–18.6	red	5.4	4.2	14.2	5.7	0.6	red	27	Sandy.
	18.6–21.0	buff	9.1	3.8	24.3	5.7	6.3	rich buff	29	
	21.0–22.0	light red	6.4	6.2	15.7	6.3	1.0	red	26+	Sandy, considerable mica.
	22.0–24.2	buff	7.6	2.6	21.0	6.5	2.9	light buff	30	
	24.2–25.5	light gray	10.0	1.9	28.3	6.8	6.2	nearly white	32	
	25.5–28.7	do	8.3	1.9	22.9	5.7	3.7	light buff	32+	Considerable mica.
	28.7–29.7	dark gray	5.0	2.6	13.4	3.6	1.6	pink	30	Sandy.
	29.7–31.2	light gray	9.2	2.4	25.8	7.0	4.5	light cream	32+	
	31.2–32.2	medium gray	6.6	3.7	17.7	6.3	1.0	dark pink	29	Do
	32.2–33.4	ochre yellow	10.9	23.3	24.2	7.3	13.0	rich red	26−	Requires more water than usual.
	33.4–34.9	yellow				3.6	10.5	red	26−	Do.
	34.9–36.2	buff	12.4	5.3	32.5	7.3	10.9	pinkish-buff	30+	Do.
	36.2–43.7	gray	12.5	1.9	34.1	7.8	9.9	almost white	32+	
	43.7–45.6	light gray	8.8	1.6	24.8	5.7	4.2	light cream	31	Considerable mica.
D–2	9.5–14.5	dark red	11.7	10.9	30.3	6.8	15.1	good red	very low	Badly cracked, bloats.
	14.5–16.8	do	12.1	9.9	31.3	6.8	16.6	do	do	Do.
	16.8–26.8	buff	11.9	3.5	31.8	7.3	12.0	pinkish-buff	31+	
	26.8–29.5	light buff	10.8	2.2	29.2	7.0	7.6	light buff	32	
	29.5–33.0	buff	8.6	2.4	22.5	6.0	4.4	buff	31+	
	33.0–40.7	do	11.0	3.0	29.8	5.7	7.3	pinkish-buff	32	
	40.7–43.7	light gray-buff	10.7	2.1	29.0	6.8	6.8	light cream	31+	High quartz.
	43.7–50.0	buff	3.7	1.3	9.1	2.6	[2] −1.0	gray-white	31+	Sandy.
	50.0–58.0	do	4.5	1.3	12.9	3.1	1.1	do	31+	

D–18	20.8–26.0	dark red	11.0	10.1	30.5	6.8	15.6	dark red	28	Cracked.
	26.0–31.0	do	11.2	9.1	31.4	6.5	15.9	salmon red	27	Do.
	31.0–39.8	light red	10.6	9.4	29.6	7.6	12.7	do	29	
	39.8–43.2	buff	8.2	2.9	22.9	6.3	3.1	pinkish-buff	31+	
	43.2–47.5	do	3.4	2.4	9.2	2.6	[2] −1.0	gray-white	31	High quartz.
	47.5–49.2	do	2.2	6.5	5.5	2.6	[2] −1.0	red	28	Do.
	49.2–57.8	do	6.9	4.4	19.6	5.2	5.0	buff	30+	
	57.8–66.8	do	5.4	1.7	15.9	4.7	1.6	grayish-buff	31	
	66.8–71.0	do	4.6	1.9	12.6	2.6	0.5	gray	30	
	71.0–73.0	gray-buff	10.9	3.8	30.0	6.8	14.6	brown	30+	Badly cracked.

[1] Firing linear shrinkage and firing color when heated at 2,000° F (cone 5).
[2] Expanded on firing.

No ceramic tests were made on residual clay, but that derived from basalt would be of very low grade because of its nontronite and ilmenite content. The residual clay derived from granodiorite and related intrusive rocks should be suitable because of its high kaolinite content, especially if the nonclay fraction, such as quartz, were washed out of it.

DESCRIPTION OF THE CLAY DEPOSITS

The clay deposits may be classified as either transported or residual; most deposits, however, contain clay of both types. The following list outlines the deposits in which each type of clay occurs.

I. Residual clay deposits.
   A. Derived from basalt.
      Excelsior, Spokane County, Wash.
      Bovill, Latah County, Idaho
      Deary, Latah County, Idaho
      Olson, Latah County, Idaho
      Stanford, Latah County, Idaho
      Canfield-Rogers, Latah County, Idaho
      Elk River, Clearwater County, Idaho
      Stockton, Kootenai County, Idaho
   B. Derived from granodiorite and related rocks.
      Benson, Latah County, Idaho
      Olson, Latah County, Idaho

II. Transported clay deposits (in the Latah formation).
   Excelsior, Spokane County, Wash.
   Bovill, Latah County, Idaho
   Deary, Latah County, Idaho
   Olson, Latah County, Idaho
   Stanford, Latah County, Idaho
   Canfield-Rogers, Latah County, Idaho
   Elk River, Clearwater County, Idaho
   Camas Prairie, Idaho County, Idaho
   Stockton, Kootenai County, Idaho
   Stanley Hill, Kootenai County, Idaho
   Deadman Creek, Spokane County, Wash.
   Fivemile Prairie, Spokane County, Wash.
   Manito-Saxby, Spokane County, Wash.

The following table shows the type of clay and percent found in each deposit.

	Residual clay		Transported clay (percent)
	Basalt (percent)	Granodiorite (percent)	
Excelsior, Spokane County, Wash.	95		5
Bovill, Latah County, Idaho	11		89
Deary, Latah County, Idaho	36		64
Olson, Latah County, Idaho	17	6	77
Stanford, Latah County, Idaho			100
Canfield-Rogers, Latah County, Idaho	9		91
Stockton, Kootenai County, Idaho		21	79
Benson, Latah County, Idaho		95	5
Elk River, Clearwater County, Idaho			100
Camas Prairie, Idaho County, Idaho			100
Manito-Saxby, Spokane County, Wash.			100
Fivemile Prairie, Spokane County, Wash.			100
Deadman Creek, Spokane County, Wash.			100

EXCELSIOR HIGH-ALUMINA CLAY DEPOSIT

The Excelsior deposit is in secs. 20, 21, 22, 23, 28, and 29, T. 24 N., R. 44 E., Willamette meridian, Spokane County, Wash. (fig. 3 and pl. 3), approximately 11 miles southeast of Spokane. State Route 3–H, the Palouse Highway, and many gravel roads traverse the area. The small village of Mica at the eastern edge of the deposit is served by two railroads, the Union Pacific and the Chicago, Milwaukee, St. Paul, and Pacific. Valleyford, a small farming community at the southern edge of the area, is served by the Great Northern Railroad.

The Excelsior deposit is in the Valleyford embayment along the eastern margin of the Columbia Plateau, where the basalt flows occupy an indentation of the mountainous area composed of older rock formations. The deposit is residual clay derived from basalt, with a minor amount of transported clay derived primarily from the weathered debris of granodiorite and related rocks. The overburden, composed mostly of the Palouse formation and partly of low-grade clay beds of the Latah formation, averages 21.4 feet thick. The ratio of overburden to clay ranges from 0.50:1 to 2.48:1. For convenience in computing reserves and in description, the deposit is divided into two areas, and each area into two or three blocks. For comparison, the size, ratio of overburden to clay, and the average content of available alumina and iron-oxide in each of the five blocks are listed below:

	Length (feet)	Width (feet)	Thickness (feet)		Ratio a:b	Available Al_2O_3 (percent)	Available Fe_2O_3 (percent)
			Overburden	Clay			
Area 1:							
West block	6,000	900	31.9	14.7	2.17:1	28.7	6.6
Middle block	4,600	1,500	26.9	16.8	1.60:1	28.1	5.5
East block	3,200	1,200	28.1	14.1	1.99:1	28.4	6.5
Area 2:							
West block	4,400	2,000	10.9	21.8	0.50:1	29.2	4.9
East block	2,700	1,200	38.7	15.6	2.48:1	28.8	5.1

FIGURE 3.—Geologic and index map of the Excelsior high-alumina clay deposit and vicinity, Spokane County, Wash.

The length and width (in feet) are maximum figures for each block of clay. The thicknesses of overburden and of high-alumina clay are averages based on drill-hole data. The available alumina percentages and the available iron oxide percentages are also averages based on drill-hole data.

The west block of area 1 (pl. 3) lies along the western margin of the Valleyford embayment. The clay in this block thins in the northern part to less than 5 feet against granite gneiss; to the east the clay has been removed by erosion. The western and southern limits are bordered by low-grade clay deposits that do not meet the requirements for high-alumina clay as determined from chemical assays. To the northern, eastern, and western parts of the middle block of area 1, the clay has been thinned to less than 5 feet by erosion. The southern boundary was arbitrarily placed where the clay is below the requirements for high-alumina clay according to the chemical assays. The boundary of the east block of area 1 is placed to the east, south, and west where the clay becomes too thin by erosion, and to the north where the clay is too low in grade to meet the high-alumina requirements.

The west block of area 2 is the largest; its northern and southern boundaries are determined by clay of too low in grade to meet the requirements of high-alumina clay. To the west, the ratio of overburden to clay becomes very high, and to the east, the clay is thinner than 5 feet. The north, west, and south boundaries of the east block of area 2 are determined by low-grade clay, and on the east the overburden is too thick. Further detailed information about the Excelsior clay deposit is given on plate 2 and in the drill-hole logs (p. 40-63).

BOVILL CLAY DEPOSIT

The Bovill deposit is in secs. 34–36, T. 41 N., R. 1 W., and secs. 1–3, 10, and 11, T. 40 N., R. 1 W., Boise meridan, Latah County, Idaho (pls. 1 and 4), south and west of the town of Bovill. State Route 8, an all-weather gravel road, crosses the deposit, and two railroads, the Chicago, Milwaukee, St. Paul, and Pacific and the Washington, Idaho, and Montana, serve Bovill. The area is drained by the West Fork of the Potlatch River and its tributaries.

The Bovill deposit is in the northeastern corner of the Helmer embayment, a relatively flat area underlain by Columbia River basalt and sediments of the Latah formation and partly surrounded by hills of older rocks. The embayment is bordered on the west by Cherry Knob, a hill underlain by volcanic rocks of Permian(?) age; on the north by granodiorite hills; and on the east and southeast by hills underlain by the Belt series and minor amounts of granodiorite.

The regional distribution of these rocks is shown on plate 1, and the local distribution is shown on plate 4.

The Bovill deposit underlies a roughly rectangular area measuring approximately 8,000 by 14,000 feet. Approximately 89 percent of the deposit is transported clay, and the residual clay derived from basalt constitutes about 11 percent. The deposit has been divided into the north, south, and west blocks for convenience in computing reserves and description. The lateral extent of the deposit is determined mainly by present stream valleys (pl. 4). Along the northern margin of the north block, however, the deposits of transported clays are very thin and low-grade, and this boundary is arbitrary. The minable limit of the high-alumina clay has been determined from the chemical assays. Drill holes B–5, 7, 8, 9, and 12 penetrate through transported clay into residual clay. In drill holes B–1, 2, 3, 4, 6, and 11 the transported clay grades downward into sand and pebble beds of low clay content. The upper limit of the high-alumina clay is sharp where it is overlain by the Palouse formation; elsewhere the clay grades upward into silt or other Latah formation sediments of low clay content. The overburden is composed of the Latah formation and Palouse formation. It averages about 10.5 feet in thickness, and the ratio of overburden to high-alumina clay is about 0.6:1.

DEARY HIGH-ALUMINA CLAY DEPOSIT

The Deary deposit is in secs. 27 and 34, T. 40 N., R. 2 W., Boise meridian, Latah County, Idaho (pls. 1 and 5), 2 miles south of the town of Deary. State Route 42, an all-weather gravel road, borders the western edge of the deposit, and the Washington, Idaho, and Montana Railroad has a station at Deary. The area is drained by Pine Creek, which flows south parallel to State Route 42.

The Deary clay deposit is at the intersection of two embayments underlain by basalt: the Helmer embayment, to the northeast, is occupied by the Bovill deposit; and the Avon embayment, to the northwest, is occupied by the Stanford and Olson clay deposits. The Deary deposit is a T-shaped area measuring roughly 3,200 feet from east to west and 2,600 feet from north to south. Approximately 64 percent of the deposit is transported clay, and 36 percent is residual clay derived from basalt.

The extent of the deposit is limited because of erosion of the sedimentary beds of the Latah formation on the northern, eastern, and southern sides (pl. 5). To the west, the sedimentary beds are too thin to be of economic value. Drill holes D–2, 9, 11, 15, and 18 are cut through transported clay and residual clay derived from basalt. In the area of these drill holes, the lower limit of the clay deposit was determined by chemical assays. The upper limit of the high-alumina

clay deposits is sharp where they are overlain by the Palouse formation or the upper flows of the Columbia River basalt. The overburden averages 14.1 feet in thickness, and the ratio of overburden to high-alumina clay is 0.3:1.

OLSON HIGH-ALUMINA AND HIGH-IRON CLAY DEPOSITS

The Olson high-alumina and high-iron clay deposits are in secs. 19, 20, and 30, T. 40 N., R. 2 W., and secs. 24 and 25, T. 40 N., R. 3 W., Boise meridian, Latah County, Idaho (pl. 1), about 3 miles southwest of the town of Deary. The area is drained by Big Bear Creek and its tributaries. The Olson deposits are at the southwest entrance of the Avon embayment, a relatively flat area underlain by the Columbia River basalt and sediments of the Latah formation and partly surrounded by hills of older rocks. The embayment is bordered on the east by Potato Hill—which is underlain by volcanic rocks of Permian(?) age, on the northeast and west by granodiorite hills, and on the north by hills underlain by the Belt series.

The Olson area contains two kinds of deposits: the high-alumina clay and the high-iron clay. The high-alumina clay deposit contains an overall average of 3.7 percent available iron oxide and 22.2 percent available alumina. The high-iron clay deposit contains an average of 17.1 percent available iron oxide and 22.4 percent available alumina. One reason for the high iron content of part of the Olson area may be the lack of good drainage that would have removed many of the iron-bearing minerals.

The Olson high-alumina deposit underlies a roughly rectangular area measuring approximately 9,000 by 14,000 feet (pl. 6). The largest portion, approximately 77 percent of the deposit, is transported clay; residual clay derived from basalt constitutes about 17 percent; and residual clay derived from granodiorite and related intrusive rocks amounts to about 6 percent. The high-alumina clay deposit has been divided into four blocks (*A*, *B*, *C*, and *D*). The lateral extent of the deposit is limited by the present stream valleys. The upper limit of the deposits of high-alumina clay may be sharp where they are overlain by the Palouse formation, or they may grade upward into silt or other sediments of low clay content of the Latah formation. The lower limit is often at the hard-rock contact at the bottom of the drill holes; however, the high-alumina clays may grade downward into materials of low clay content. The overlying Palouse formation and low-grade sediments of the Latah formation average 15.9 feet in thickness, and the ratio of overburden to high-alumina clay is about 0.5:1.

The high-iron clay deposit underlies a roughly rectangular area measuring approximately 8,000 by 11,000 feet (pl. 6). The largest

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portion, approximately 95 percent of the deposit, is residual clay derived from basalt; transported clay constitutes about 5 percent. The overburden is the Palouse formation, which averages about 14.3 feet thick, and the ratio of overburden to clay is about 0.3:1. For details on the available alumina and iron oxide content of the Olson deposits see plate 6 and pages 71–125.

STANFORD CLAY DEPOSIT

The Stanford deposit is in secs. 1 and 12, T. 40 N., R. 3 W., and secs. 6 and 7, T. 40 N., R. 2 W., Boise meridian, Latah County, Idaho (pl. 1). State Route 42, an all-weather gravel road, crosses the deposit, and the Washington, Idaho, and Montana Railroad has a station at Stanford. The area is drained by the Big Bear Creek and its tributaries. The deposit is in the northwestern corner of the Avon embayment, a relatively flat area underlain by the Columbia River basalt and sediments of the Latah formation. To the east, the embayment is bordered by Potato Hill—which is underlain by volcanic rocks of Permian(?) age; to the northeast and west, by granodiorite hills, and to the north, by hills underlain by the Belt series. The regional distribution of these rocks is shown on plate 1, and the local distribution is shown on plate 7.

The Stanford clay deposit consists entirely of transported clay of the upper Latah formation, but residual clay derived from basalt and from granodiorite occurs in the area surrounding the deposit. The deposit has been divided into two blocks (west and east) indicating clay that meets the high-alumina requirements. The lateral extent of the deposit is determined mainly by the present stream valleys and the chemical assays of clay from surrounding drill holes. The overburden is composed mostly of the Palouse formation, which averages about 11 feet thick. The ratio of overburden to high-alumina clay is about 0.8:1. For details on the available alumina and iron oxide content and the thickness of clay in the Stanford deposit see plate 7 and pages 126–127.

CANFIELD-ROGERS CLAY DEPOSIT

The Canfield-Rogers deposit is in the southern part of T. 40 N., R. 5 W., and T. 40 N., R. 6 W., and in the northern part of T. 39 N., R. 5 W., and T. 39 N., R. 6 W., Boise meridian, Latah County, Idaho (pl. 1), north and east of the town of Moscow. U.S. Highway 95 and State Route 8 cross the deposit, and three railroads, the Great Northern, Northern Pacific, and Union Pacific, serve Moscow. The area is drained by the South Fork of the Palouse River and its tributaries. The Canfield-Rogers deposit is in the eastern part of the Moscow embayment, a relatively flat area underlain by Columbia River basalt and sediments of the Latah formation and partly surrounded by hills

of older rocks. The embayment is bordered on the north and south by hills underlain by the granodiorite of Late Jurassic or Cretaceous age, and to the southeast by hills underlain by the Belt series.

The deposit underlies an area measuring approximately 18,000 by 20,000 feet. The largest portion, about 91 percent, of the deposit is transported clay; residual clay derived from basalt constitutes 9 percent. The deposit has been divided into the west, middle, and east blocks (pl. 8) to indicate where the clay would most likely meet the high-alumina clay requirements. The extent of the deposit is determined mainly by the present stream valleys. Along the boundaries of the east and middle blocks the transported clay probably becomes thin and low grade, and these boundaries are arbitrary. The minable limit of the high-alumina clay has been determined from the chemical assays. Drill holes C–5, 8, and 10 pass through transported clay into residual clay derived from basalt. In drill holes C–2 and C–13, the transported clay grades downward into sand and pebble beds of low clay content, but drill hole C–3 ends in high-grade transported clay. The upper limit of the high-alumina clays is sharp where they are overlain by the Palouse formation; elsewhere the high-alumina clays grade upward into silt or other sediments of low clay content of the Latah formation. The overburden averages 10.4 feet thick, and the ratio of overburden to high-alumina clay is about 0.9:1. To further develop this area for high-alumina clay, much additional systematic drilling will be needed.

STOCKTON AND STANLEY HILL CLAY DEPOSITS

The Stockton deposit is in parts of secs. 8, 9, 15, and 16, T. 50 N., R. 4 W., Boise meridian, Kootenai County, Idaho (fig. 4), about 2 to 3 miles northwest of the town of Coeur d'Alene. U.S. Highway 95 borders the deposit on three sides. Approximately half a mile north of the deposits, the Northern Pacific Railroad connects the area with Spokane, Wash., 25 miles to the west. The deposit is on the eastern margin of the Columbia Plateau physiographic province. Altitudes range from 2,400 to about 2,510 feet; however, local relief seldom exceeds 50 feet. Parts of the area are covered with glacial debris from the last continental glacier. The area is drained by the Spokane River and its tributaries.

The Stockton deposit is on a terrace underlain by the Columbia River basalt and sediments of the Latah formation, and is about 300 feet above the Spokane River. The terrace is bounded on the north by recent landslides and talus deposits, on the east and southeast by glacial deposits, and on the south and west by hills of granite gneiss (pl. 9).

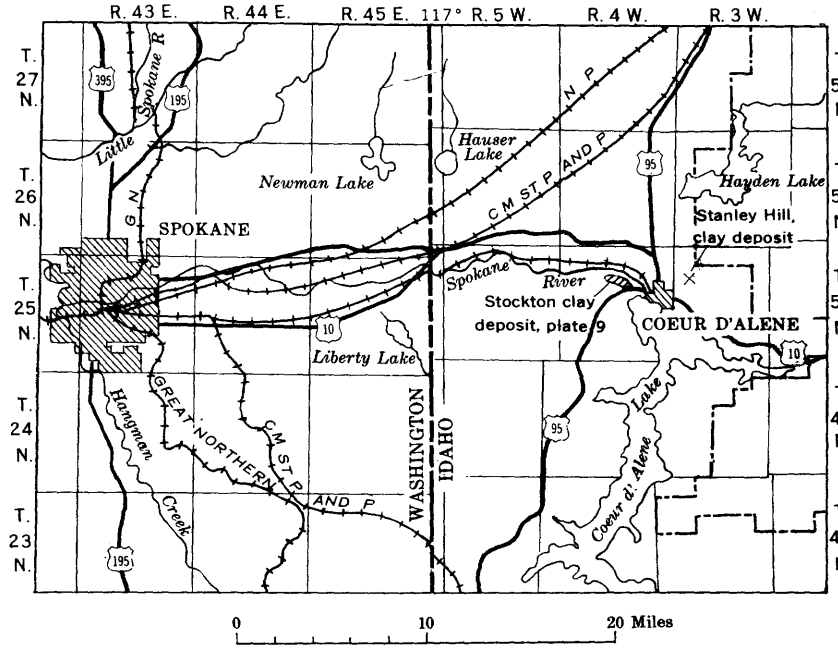

FIGURE 4.—Index map of the Stockton and Stanley Hill clay deposits, Kootenai County, Idaho.

The Stockton deposit, consisting of 79 percent transported clay and 21 percent residual clay derived from granodiorite and related intrusive rocks, has been divided into the west, southwest, central, east, and north blocks. Four of the five blocks occur in the valley along the contact between the Columbia River basalt and the granite gneiss. The fifth block is at the north edge of the basalt ridge. The overburden at each of the five blocks is only a few feet thick, and is composed of soil, unconsolidated older glacial debris, or loose boulders. The clay in the west block is approximately 1,200 feet long, 150 to 200 feet wide, and 10 to 20 feet thick. The clay in the southwest block is approximately 600 feet long, 300 feet wide, and 10 to 15 feet thick. The overburden for both blocks is 1 to 2 feet of soil. No chemical assays or ceramic tests were made on the clay from these two blocks. The clay in the central block is approximately 2,200 feet long and 450 feet wide; the average thickness is about 18 feet, and the overburden ia 1 to 5 feet of soil and a few loose boulders. The east block is approximately 1,500 feet long, 400 feet wide, the clay averages about 12 feet thick, and the overburden consists of 1 to 10 feet of soil and other glacial deposits. The clay in the north block is about 375 feet from north to south and 200 feet from east to west, and averages about 17 feet thick; the overburden ranges from a few inches to 8 feet of unconsolidated glacial till and loose basalt talus.

The Stanley Hill clay deposit occupies a large part of the NE¼SE¼ sec. 7, T. 50 N., R. 3 W., Boise meridian (fig. 4), Kootenai County, Idaho. It is about 2 miles northeast of the town of Coeur d'Alene. Stanley Hill is an eastward-trending ridge that is underlain by quartzite of the Belt series of the Precambrian. Three small elliptical hills on the south slope of Stanley Hill are underlain by Columbia River basalt and clays of the Latah formation. The transported clay here was found to be at least 60 feet deep. No analysis was made of the clay, and the deposit was not mapped in detail. To further develop the Stockton deposit and to explore the Stanley Hill deposit, additional drilling and considerable sampling for analysis will be necessary.

BENSON CLAY DEPOSIT

The Benson clay deposit has produced a little more than 150,000 tons of clay for superior fireclay products. It is about 3½ miles northeast of Troy and occupies parts of secs. 27, 28, 33, and 34, T. 40 N., R. 3 W., Boise meridian. State Route 8, an all-weather gravel road, skirts the deposit on the south, and the nearest rail point is Troy, a station on the Northern Pacific Railroad. There are no permanent flowing streams in the area and very little groundwater is available.

The deposit is near the margin of the Columbia Plateau. It consists of residual clay derived from granodiorite and related intrusive rocks, and is gradationally bounded on the north, east, and west by relatively fresh granodiorite. To the south, the deposit is bounded by overlapping flows of the upper part of the Columbia River basalt. The Palouse formation overlies the entire deposit, with a thickness from 10 to 40 feet.

The Benson deposit has been developed by two pits: the Benson pit in the southwest part of the deposit and the Johnson pit in the southeast part of the deposit. The Calen pit lies between the Benson and Johnson pits, but this pit was dug for prospecting and not for development.

Clay is not exposed at the surface in the Benson deposit. Along the southern edge of the deposit, the upper basalt flows and the Palouse formation make up the overburden, and the rest of the deposit is covered with the Palouse formation only. At the Johnson pit, the overburden reaches a maximum of 40 feet and consists of 5 to 10 feet of sand and clay, 10 to 25 feet of basalt, and 10 to 15 feet of the Palouse formation. At the Calen pit, the Palouse formation, as much as 8 feet thick, is the only overburden. At the Benson pit, the basalt has been removed north of the midline of the pit, but it thickens to the south until it reaches at least 80 feet at the south wall of the pit. The Palouse formation is 15 to 20 feet thick at the Benson pit.

The clay, preserving the texture of the granodiorite and related

intrusive rocks, is a soft white plastic clay composed of kaolin, quartz, muscovite, and some kaolinized feldspars. The upper few feet is usually stained yellow by limonite carried down in solution from the overlying Palouse formation. Decomposed pegmatite and aplite dikes have been observed at the Johnson pit, The absence of dickite, which is formed by hydrothermal solutions, lends support to the theory that the deposit was formed by weathering and not as a result of hydrothermal activity, as has been suggested in some reports.

The existing pits indicate that the Benson clay deposit is probably not quite a square mile in extent. The depth of clay is unknown, because none of the drill holes that have penetrated the residual clay extended into unaltered rock. Also the contact between clay and fresh rock is undoubtedly gradational and varies in depth from place to place. At the Johnson pit, 20 to 30 feet of clay can be observed; at the Calen pit a 60-foot drill hole did not reach fresh rock; near the Benson pit several auger holes 70 feet deep, including 20 feet of overburden, were still in clay; and a 35-foot auger hole, collared at the haulage adit beneath the Benson pit, was in clay all the way. These measurements indicate a total thickness of 115 feet of residual clay.

The only available chemical analyses of the clay are those published by Tullis and Laney (1933, p. 493) and Hodge (1938, p. 643). They indicate that the crude clay contains about 20 percent alumina, 2 percent iron oxide, and 70 percent silica.

OTHER CLAY DEPOSITS

ELK RIVER DEPOSIT

The Elk River clay deposit is in the NE½ sec. 3, T. 39 N., R. 2 E., Boise meridian, Clearwater County, Idaho, about 1 mile south of the hamlet of Elk River (pl. 1), a station on a branch line of the Chicago, Milwaukee, St. Paul, and Pacific Railroad. The deposit is on a ridge between Lindley and Elk Creeks, tributaries to the North Fork of the Clearwater River. A measured section along the road that crosses this ridge indicates, from bottom to top, the following: lower flows of the Columbia River basalt, of unknown thickness because the base is not exposed; the lower part of the Latah formation, about 70 feet thick—consists of white clay (stained red in places by iron oxide), muscovite, and quartz and was found to be deficient in available alumina (drill hole ER–3); the middle basalt flows, 60 feet thick, in which the upper 14 feet are semidecomposed (drill hole ER–1); transported clay of the upper part of the Latah formation, approximately 50 feet thick, consisting of yellow, pink, and brown plastic clay with little or no sand and containing an average of 26 percent available alumina and 2.5 percent iron oxide (drill hole ER–2); remnants of upper flows of the Columbia River basalt 5 to

25 feet thick cap the ridge. Drill hole logs and the analyses made by the U.S. Bureau of Mines of the three drill holes are given on page 145. The amount of clay with a content of available alumina high enough to meet the requirements seems to be too small to be worthwhile.

CAMAS PRAIRIE DEPOSITS

The Camas Prairie deposits are scattered clay occurrences near Grangeville, Idaho County, Idaho. The Camas Prairie is a broad gently rolling area of hills bounded on the southwest and west by the Salmon River canyon, on the north and east by the Clearwater River canyon, and on the south by the Idaho mountains. U.S. Highway 95 crosses the area, and two railroads, the Northern Pacific Railroad with its terminus at Sites and the Camas Prairie Railroad with its terminus at Grangeville, serve the area.

The Camas Prairie is underlain by the Columbia River basalt and sediments of the Latah formation. Steptoes of granodiorite protrude through the basalt north of the town of Cottonwood along an eastward-trending ridge that is now largely buried. Residual clay developed from the granodiorite can be found in places along this ridge, but erosion has removed most of it.

The clay deposits of Camas Prairie seem to be small, and some have considerable overburden of either Columbia River basalt or Palouse formation or both. According to the drill-hole assay information, several deposits exceptionally high in available alumina (see p. 146). Drill hole CP–2 was collared about 5 feet below the top of a plastic red transported clay bed overlain by basalt, and exposed in a road cut about one mile south of Grangeville. Drill hole CP–3 was drilled at the base of a 3-foot clay exposure in a road cut on U.S. Highway 95 about 2½ miles southwest of Grangeville. Here the transported clay is overlain by 4 feet of basalt that increases in thickness to the east and southeast; to the north and west the transported clay has been removed by erosion. About 40 feet of transported clay is reported in the vicinity of drill hole CP–4. The overburden of gravel and basalt remnants is about 40 feet thick a short distance south of the drill hole, but it becomes much thinner a short distance north of the drill hole. Although the area of clay exposed near the drill holes is small, and the clay occurs under considerable overburden, it is quite possible that large deposits of high-alumina clay with thin overburden do exist in the Camas Prairie area. It would, however, take considerable drilling and testing to find any additional clay deposits.

MANITO-SAXBY DEPOSITS

The Manito-Saxby area is approximately 18 miles southeast of the center of the city of Spokane, Wash. It is an area that measures

roughly 2 miles from north to south and 5 miles from east to west. It includes sections 1–5 and 8–13 inclusive in T. 23 N., R. 45 E., Willamette meridian in Washington, and sections 6, 7, and 18, T. 48 N., R. 6 W., Boise meridian in Idaho. Manito, in the western part of the area, and Saxby, in the eastern part, are way stations about 4 miles apart along the tracks of the Chicago, Milwaukee, St. Paul, and Pacific Railroad. The area is traversed by graded and graveled roads.

The Manito-Saxby area lies at the southern edge of and 2,600 feet below the summit of the 5,200-foot Mica Peak. This peak is composed of granite gneiss of Cretaceous age, which is considered to be the major source of sediments that made up the Lata formation in this area. In several places along the southern flank of the peak, evidence was found that the Columbia River basalt overlies residual clay derived from granite gneiss.

A railroad cut on the north side of the tracks at the Manito station exposes transported clay. Here the Palouse formation, gravel, and red and yellow clay form an overburden of about 20 feet on a bed of sandy, grayish-white, transported clay that is at least 10 feet thick, but the total thickness is not known. The U.S. Bureau of Mines analyzed two channel samples from the cut, and the transported clay was found to contain 22.7 and 25.4 percent available alumina and 0.9 and 1.0 percent available iron oxide.

The Chicago, Milwaukee, St. Paul, and Pacific Railroad tracks pass through a cut about one-half mile southeast of the Saxby station. Sandy, red residual clay derived from gneiss and overlain by a few feet of Palouse formation is exposed throughout the cut, which is 15 feet high and 500 feet long. The bands of white clay scattered through the red clay are probably altered pegmatite dikes. Two channel samples from the south side of the cut were analyzed by the U.S. Bureau of Mines. The upper sample of plastic white and red clay from a depth of 6 to 11 feet assayed 32.9 percent available alumina and 3.2 percent available iron oxide. The lower sample of gray clay from a depth of 11 to 12 feet assayed 23.4 percent available alumina and 1.2 percent available iron oxide. The extent of these clay deposits is unknown.

FIVEMILE PRAIRIE CLAY DEPOSIT

The Fivemile Prairie clay deposit (T. 26 N., R. 42 E., Willamette meridian) is about 5 miles northeast of Spokane, Wash. The U.S. Bureau of Mines drilled 3 holes in sec. 22, 4 holes in sec. 25, and 4 holes in sec. 26. Of the 11 holes drilled, clay was found in 9, with an average thickness of about 31 feet. The material of the Latah formation, found by drilling, consisted of white, gray, yellow, and brown clay; gray and brown iron-stained micaceous and sandy clay;

white and yellow sand; and limonite layers. Samples of clay analyzed by the U.S. Bureau of Mines were found to contain approximately 5 to 16 percent available alumina and 1 to 15 percent available iron oxide. Although the clay sampled does not meet the requirements of a high-alumina deposit, it is possible that some of the clay may meet the standards of intermediate to high-heat-duty refractory clays.

DEADMAN CREEK DEPOSIT

The Deadman Creek clay deposit (secs. 15, 26–28, 31–33, T. 27 N., R. 44 E., Willamette meridian) is about 3.5 miles northeast of Spokane, Wash. The U.S. Bureau of Mines drilled one hole in each section and 4 holes in section 27. Of the 10 holes drilled, clay was found in 8, but only 5 had clay worth sampling and assaying. The sedimentary material of the Latah formation, found by drilling, consisted of gray and yellowish-gray clays; yellow, red, brown, and gray sand clays; white and yellow sand; micaceous sand; and limonite layers. The analyzed samples of transported clay contained from 7.8 to 21.5 percent available alumina and from 1.3 to 5.6 percent available iron oxide. Although the results of the sampling do not seem encouraging, it is possible that several local clay bodies may be found in the area that could be used in some phase of the ceramic industry.

CLAY RESERVES

In calculating the reserves in each deposit studied in eastern Washington and northern Idaho, several well-known methods were employed to determine the volumes of each, depending upon the distance between drill holes. The volume was converted to wet tons (weight of clay in place) by using an average specific gravity of 2.13, which is equivalent to 15.40 cubic feet per ton. Wet tons were converted to dry tons by using the percent of moisture driven off at 130° C, which is 29.0 percent for residual clay derived from basalt, 14.0 percent for residual clay derived from granodiorite and related intrusive rocks, and 24.0 percent for transported clay. Thus, 21.2, 17.5, and 19.8 cubic feet respectively for each type of clay in place equals 1 ton of dry clay.

The clay deposits in the Palouse hills contain at least 300 million tons (dry) of clay suitable for the kind of aluminum ore set up by the U.S. Bureau of Mines and War Production Board as outlined on page 20 of this report. A considerably greater quantity of clay suitable for ceramic products, such as structural brick and drain tile and superheat duty refractory brick. About 90 percent of the tonnage estimate listed above occurs in four major deposits of Latah County, Idaho—Bovill clay deposit, Olson high-alumina clay deposit, Canfield-Rogers clay deposits, and Benson clay deposit.

RECOMMENDATIONS FOR FUTURE WORK

Recognition of the three types of clay (residual clay derived from basalt, residual clay derived from granodiorite and related intrusive rocks, and transported clay) and the rocks from which they originate will be very useful in future prospecting for high-alumina clay deposits in the Palouse hills area. The extent of the region on which the three types of clay were once formed or deposited can only be inferred because in places the clays subsequently were deeply buried by the upper basalt flows and by the Palouse formation or removed by erosion before the deposition of the Palouse formation. The most likely area for the occurrence of the clay is near the contact of the Columbia River basalt with the older granodiorite and related intrusive rocks of part of the Idaho batholith, or near the contact of the basalt flows with the older rocks of the Belt series of the Precambrian. Here the residual clays and the transported clay have been protected from erosion by relatively thin flows of the upper basalt prior to the deposition of the Palouse formation. Parts of Whitman County, Wash., along with Benewah, Nez Perce, and Lewis Counties in Idaho, and the five counties mentioned in the text (Spokane, Kootenai, Latah, Clearwater, and Idaho) can be considered the most favorable area for the occurrence of high-alumina clay.

Some surface prospecting has already been done in the more easily accessible areas and where the Palouse formation is very thin. Because the Palouse formation occurs as a blanket with varying thickness (thick on the flanks of the hill and thinner on the top), any future prospecting in the Palouse hills area will have to be by drilling (hand or machine auger) and possibly bulldozer pits for exploratory work. Additional geologic mapping, sampling, analyzing, and testing would yield much valuable information and no doubt greatly increase known reserves in the clay region of eastern Washington and northern Idaho.

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LOGS OF DRILL HOLES AND RESULTS OF ASSAYS

Drill hole logs and results of assays of the Excelsior deposit

[Formation symbols: Qb, Quaternary bog deposits; Qt, Quaternary terrace deposits; Qp, Palouse formation. Tl, Latah formation—Tlu, upper part; Tll, lower part. Tc, Columbia River basalt—Tcu, upper flows; Tcl, lower flows. KJg, Cretaceous granodiorite and related rocks]

Lithologic unit			Sample unit			
Formation symbols	Depth (feet)	Description	Length (feet)	Ignition loss (percent)	Available Fe_2O_3 (percent)	Available Al_2O_3 (percent)
Drill hole E-1. Coordinates, 24,010N, 14,035E						
Qp	8.0	Soil and Palouse formation	0.0–37.0			
Tlu	11.0	Gravel, transported; gneiss pebbles, poorly sorted.				
KJg	16.0	Clay; residual from gneiss; poor quality.				
	37.0	Gneiss, medium-grained, quartzitic; contains biotite clusters, slightly weathered.				
		Granitic gneiss.				
Drill hole E-2. Coordinates, 25,000N, 15,000E						
Qp	27.0	Soil and Palouse formation.	0.0–58.0			
Tlu	42.0	Clay, transported, gray, sandy and micaceous, plastic.	58.0–65.0	11.1	3.1	31.3
			65.0–73.0	9.9	16.4	23.2
	57.0	Gravel, transported; gray plastic clay at 48.0–53.0 ft.	73.0–80.0	10.2	8.7	26.7
Tcl	65.0	Clay; blue; residual from basalt; white kaolin amygdules and streaks; some iron staining.	80.0–87.0	9.4	16.6	22.2
	69.0	Clay; residual from basalt; brown and dark-gray.				
	76.0	Clay; residual from basalt; blue and blue-gray.				
	78.5	Clay; residual from basalt; greenish-gray, iron-stained.				
	80.0	Clay; residual from basalt; blue; white kaolin amygdules.				
	87.0	Basalt, semidecomposed, brownish-gray, iron-stained.				
		Basalt.				
Drill hole E-3. Coordinates 24,475N, 16,130E						
Qp	3.0	Soil and Palouse formation.	0.0–28.0			
Tlu	29.0	Clay, transported, light-gray; some sand and mica; last 0.5 ft. iron-cemented sand.	28.0–31.0	10.4	5.8	27.2
			31.0–35.0	3.0	2.9	8.9
	31.0	Clay, transported, white, plastic, dense.	35.0–36.0			
Tcl	35.0	Clay; residual from basalt; blue-gray; white kaolin amygdules.				
	36.0	Basalt, semidecomposed, brown.				
		Basalt.				
Drill hole E-4. Coordinates 24,550N, 16,680E						
Qp	30.0	Soil and Palouse formation.	0.0–47.0			
Tlu	45.0	Sand and clay, transported, gray, micaceous, plastic.	47.0–50.0	9.2	16.1	21.9
			50.0–57.0	11.1	2.0	32.9
	50.5	Clay, transported, limonitic.	57.0–60.5	9.3	3.8	27.2
Tcl	51.5	Clay; residual from basalt; white and tan-gray.	60.5–65.0			
	58.0	Clay; residual from basalt; blue and blue-gray; white kaolin amygdules.				
	63.0	Clay; residual from basalt; blue, plastic.				
	65.0	Basalt, semidecomposed, brown-black.				
		Basalt.				

Drill hole logs and results of assays of the Excelsior deposit—Continued

Lithologic unit			Sample unit			
Formation symbols	Depth (feet)	Description	Length (feet)	Ignition loss (percent)	Available Fe_2O_3 (percent)	Available Al_2O_3 (percent)
Drill hole E–5. Coordinates 24,890N, 18,320E						
Qp	14.0	Soil and Palouse formation.	0.0–17.0			
Tcl	21.0	Clay; residual from basalt; blue-gray and brown; white kaolin amygdules.	17.0–21.0	5.6	14.1	15.0
	26.0	Basalt, black, amygduloidal.				
Drill hole E–6. Coordinates 24,520N, 18,805E						
Qp	0.0–19.0	Soil and Palouse formation.	0.0–24.0			
	19.0–24.0	Gravel, gneiss pebbles.	24.0–30.0	8.7	20.0	19.4
Tcu	36.0	Clay; residual from basalt; blue; white kaolin amygdules, upper 3 ft. waxy. 6-in. seam of tan, iron-stained palogonite at 27 ft.	30.0–36.0	9.0	15.4	21.3
			36.0–42.0	7.5	14.4	17.0
			42.0–48.0	7.9	13.7	17.9
			48.0–54.0	7.2	12.6	15.6
	41.5	Clay; residual from basalt; tan, palagonitic; mixed with micaceous clayey sand.	54.0–59.0	6.8	12.5	16.6
			59.0–65.0	7.5	9.7	19.4
			65.0–71.0	8.4	3.7	24.6
	59.5	Clay; residual from basalt; tan, palagonitic; about one-third blue and blue-gray clay.	71.0–74.5	5.9	4.2	17.2
	63.5	Clay; residual from basalt; blue, waxy, vesicular.				
	66.0	Clay; residual from basalt; tan, palagonitic.				
	68.0	Clay; residual from basalt; blue.				
Tlu	74.5	Sand, transported, clayey, micaceous.				
	81.0	Sand, transported, brown, micaceous, iron-stained.				
Drill hole E–7. Coordinates 24,030N, 13,525E						
Qp	48.0	Soil and Palouse formation.	0.0–65.0			
Tlu	64.0	Sand and gravel, transported, gneiss, some white clay.	65.0–71.0	5.8	2.3	15.4
			71.0–77.0	6.9	13.2	14.6
	77.0	Sand, transported, yellow and yellowish gray, clayey and micaceous.	77.0–79.0	11.6	3.0	31.1
			79.0–85.0	6.6	4.0	19.7
	78.0	Clay, transported, white, powdery kaolin, bottom 2 in. sandy.	85.0–88.0	3.0	6.8	9.3
	79.0	Clay, transported, gray, powdery kaolin.				
Tcl	80.0	Clay; residual from basalt; blue; white kaolin amygdules.				
	82.0	Clay; residual from basalt; gray; some white streaks.				
	88.0	Basalt, semidecomposed, gray and brown.				
		Basalt.				
Drill hole E–8. Coordinates 23,890N, 14,515E						
Qp	31.0	Soil and Palouse formation; some granite gravel.	0.0–31.0			
			31.0–33.0	10.1	2.5	29.9
Tcl	33.0	Clay, dark blue; completely decomposed vesicular basalt; vesicles filled with white and yellow transported kaolinite.	33.0–36.0	10.2	3.1	29.3
			36.0–41.5	3.6	8.5	9.0
			41.5–45.5	2.6	7.0	5.8
			45.5–48.5	4.0	13.2	9.0
	35.0	Clay; tannish- and bluish-gray; residual from basalt; narrow seams and amygdules of transported, white kaolinite; disseminated minute specks of ilmenite.	48.5–53.0	4.1	13.0	8.5
			53.0–55.0	5.8	13.7	13.5
			55.0–59.0	9.3	5.1	24.4
			59.0–63.0	9.3	6.9	25.3
			63.0–67.0	9.2	7.9	25.3
	37.5	Lost core (probably similar to 33–35 ft).	67.0–71.0	6.8	15.8	15.8
	38.0	Basalt, semidecomposed, yellow-green, hard.	71.0–77.0	6.6	21.3	14.7
			77.0–82.0	7.4	23.6	15.2

Drill hole logs and results of assays of the Excelsior deposit—Continued

Lithologic unit			Sample unit			
Formation symbols	Depth (feet)	Description	Length (feet)	Ignition loss (percent)	Available Fe_2O_3 (percent)	Available Al_2O_3 (percent)
		Drill hole E-8—Continued				
Tcl	40.5	Clay; light-blue-gray; dense; residual from basalt; contains scattered hard spots.				
	47.0	Basalt, slightly altered, brown-black, even-grained, hard; spots and zones of gray-blue clay along joints; at 46.5 ft hard, blue basalt; at 47 ft, 6-in iron streak.				
	48.0	Clay; dark-blue, vesicular; residual from basalt; vesicles filled with tan and white kaolinite.				
	49.5	Basalt, semidecomposed, light yellowish-green, even-grained; green nontronite specks and black ilmenite specks.				
	51.0	Lost core. Probably similar to 48.0–54.0 ft.				
	54.0	Basalt, semidecomposed, grayish-green, some blue; half is hard; some waxy, green nontronite spots and streaks; At a 6-in limonite seam at 53 ft.				
	67.0	Clay; yellow, palagonitic, plastic; residual from basalt; mixed with white transported kaolinite and some diatoms; scattered spots of blue basalt clay as large as 6 inches in diameter; some of have centers of unaltered vesicular basalt. Probably a pillow basalt.				
	69.0	Basalt, slightly decomposed, black-brown.				
	76.0	Clay; residual from basalt; contains yellow, and green zones; palagonitic, waxy; with brown waxy clay scattered through the green zones. 1 ft of black-brown, semidecomposed basalt at 71 ft, similar to that at 67.0–69.0 ft and 1 ft of mixed yellow-green palagonitic clay, and brown, semidecomposed, fine-grained basalt at 74 ft.				
	82.0	Basalt, partly decomposed, dark-brown, fine-grained; last 3 or 4 ft mixed with one-third to one-half yellow and green palagonitic clay.				
		Basalt.				
		Drill hole E-9, Coordinates 24,000N, 15,505E				
Qp	5.0	Soil and Palouse formation.	0.0–27.0	------	------	------
	23.0	Palouse formation and gravel.				
Tcl	27.0	Basalt, partly altered, slightly vesicular; contains ilmenite specks, olive-green nontronite spots.				
		Drill hole E-10. Coordinates 23,960N. 16,500E				
Qp	42.0	Soil and Palouse formation.	0.0–42.0	------	------	------
Tlu	47.5	Clay, transported, gray-white, plastic.	42.0–48.0	7.5	1.3	21.2
Tcl	57.0	Clay; blue and blue-gray; residual from basalt; some white kaolinite amygdules.	48.0–53.0	11.0	1.3	31.8
			53.0–57.0	9.7	6.6	26.8
			57.0–63.0	7.7	20.8	16.7
	64.0	Basalt, semidecomposed, gray; much iron stain and green nontronite.	63.0–69.0	6.0	14.9	14.5
	70.0	Basalt, partly decomposed, gray-black; abundant green nontronite; hard spots.	69.0–70.0	------	------	------
		Basalt.				

Drill hole logs and results of assays of the Excelsior deposit—Continued

Lithologic unit			Sample unit			
Formation symbols	Depth (feet)	Description	Length (feet)	Ignition loss (percent)	Available Fe_2O_3 (percent)	Available Al_2O_3 (percent)
Drill hole E-11. Coordinates 23,960N, 17,500E						
Qp	7.0	Soil and Palouse formation	0.0– 8.0			
Tcl	8.0	Basalt, green nontronite.				
		Basalt.				
Drill hole E-12. Coordinates 23,903N, 18,500E						
Qp	16.5	Soil and Palouse formation	0.0–17.0			
Tcl	24.0	Clay; dark blue and brown; residual from basalt.	17.0–23.0	9.5	19.8	22.7
			23.0–28.0	8.6	19.3	20.0
	38.0	Clay; blue and some brown; residual from basalt; green nontronite streaks, some amygdules.	28.0–31.0	9.4	14.6	22.4
			31.0–37.0	9.6	13.1	24.0
			37.0–43.0	8.5	17.7	20.6
	42.0	Clay; brown; residual from basalt; tan amygdules.	43.0–49.0	8.4	18.8	20.3
	47.0	Clay; blue, blue-gray, and brown; residual from basalt; iron streaks				
	50.0	Clay; blue; residual from basalt.				
		Basalt.				
Drill hole E-13. Coordinates 23,000N, 13,010E						
Qp	34.0	Soil and Palouse formation, granitic sand at base.	0.0–33.5			
			33.5–42.0	10.4	1.7	28.5
Tlu	41.0	Clay, transported, gray and white, plastic.	42.0–45.0	4.2	7.9	11.1
			53.0–57.0	3.4	12.4	7.4
Tcl	45.0	Clay; residual from basalt; amygduloidal.				
	46.0	Basalt, partly altered, brown.				
	53.0	Basalt, black; vesicles filled with tan clay.				
	58.0	Basalt, semidecomposed, black; iron streaks near top.				
		Basalt.				
Drill hole E-14. Coordinates 23,015N, 14,015E						
Qp	43.5	Soil and Palouse formation. Granite sand and occasional pebbles of green nontronite and decomposed basalt.	0.0–43.5			
			43.5–50.0	11.4	0.9	32.5
			50.0–53.5	11.8	1.0	32.6
Tcl	54.0	Clay, residual from basalt, blue; amygdules and streaks of white kaolinite; very fine and even grained from 48 ft on.	53.5–55.0	9.5	17.8	21.8
			55.0–56.0	9.8	13.9	20.5
			56.0–57.0	9.6	22.8	20.0
			57.0–59.0	9.8	10.7	25.5
	59.0	Clay, residual from basalt; banded gray, green, and brown; high in iron; some only semidecomposed; small spot of semidecomposed palagonite.	59.0–66.0	8.2	38.7	13.3
			66.0–69.0	5.0	16.1	10.9
			71.0–74.0	2.7	12.8	6.4
			74.0–76.0	7.1	32.3	11.1
	66.0	Basalt, semidecomposed, brown and gray-green, waxy; contain limonite crusts; nontronite spots, and vesicle linings; hard spots near bottom.	76.0–77.0	7.6	33.8	11.6
			77.0–82.0	7.0	39.0	8.8
	69.0	Clay, residual from basalt; blue; middle part strongly streaked and spotted by hard waxy green nontronite.				
	74.0	Basalt, partially decomposed, black-blue, vesicular, hard; nontronite spots.				
	77.0	Basalt, similar to 59.0–66.0 ft.				
	80.0	Basalt, semidecomposed; upper 6 in blue; rest green from nontronite.				
	82.0	Basalt, abundant limonite.				
		Basalt.				

Drill hole logs and results of assays of the Excelsior deposit—Continued

Lithologic unit			Sample unit			
Formation symbols	Depth (feet)	Description	Length (feet)	Ignition loss (percent)	Available Fe_2O_3 (percent)	Available Al_2O_3 (percent)
Drill hole E–15. Coordinates 22,975N, 15,090E						
Qp	25.0	Soil and Palouse formation.	0.0–24.5			
Tcl	27.0	Clay; residual; from bassalt; blue vesicular.	24.5–27.0	5.2	4.1	13.5
	32.0	Clay; residual from basalt; tan and bluish-gray; some hard spots.	27.0–32.0	5.2	2.4	15.4
	32.5	Clay; residual from basalt; blue, vesicular.	32.0–35.0	3.6	3.4	9.7
	35.0	Basalt, black and dark-gray, vesicular; 4-in of yellow clay.	35.0–40.0	4.6	4.8	12.2
	48.0	Pillow basalt, slightly decomposed, and associated tuff; some vesicles filled with tan clay; streaks and spots of green-yellow nontronite at 35 ft; 6-in iron streak at 38 ft.	40.0–48.0	5.4	7.9	13.9
Drill hole E–16. Coordinates 22,990N, 16,000E						
Qp	30.0	Soil and Palouse formation.	0.0–41.0			
	39.0	Sand, gray, micaceous and clayey.	41.0–43.0	5.6	0.9	14.7
Tlu	47.0	Clay, transported, gray, plastic.	47.0–49.5	10.2	22.4	21.2
	49.5	Limonite.	49.5–53.0	11.4	3.2	31.6
Tcl	63.0	Clay; residual from basalt; blue; vesicules and cracks filled with white kaolin; 4-in band of yellow clay at 61 ft.	53.0–58.0	12.0	1.1	32.9
			58.0–63.0	11.5	1.8	32.8
			63.0–65.0	9.4	5.8	26.2
	67.5	Clay; residual from basalt; blue-gray and green-brown; hard spots begin at 65 ft; yellow-green nontronite fills cracks and vesicles.	65.0–67.5	5.9	6.3	16.5
		Basalt.				
Drill hole E–17. Coordinates 22,970N, 16,985E						
Qp	3.0	Soil and Palouse formation.	0.0–25.0			
	11.0	Pebbles of green nontronite and white quartz.				
Tcu	25.0	Basalt, black, hard.				
		Basalt.				
Drill hole E–18. Coordinates 22,950N., 17,920E						
Qp	38.5	Soil and Palouse formation. Some gravel at bottom.	0.0–35.0			
			35.0–41.0	9.0	17.1	19.5
Tcl	41.0	Clay; residual from basalt; light-blue-gray.	41.0–43.0	9.0	15.7	19.7
			43.0–48.0	9.0	14.8	21.6
	42.5	Basalt, brown, semidecomposed.	48.0–53.0	9.8	13.1	25.1
	52.5	Clay; residual from basalt; light-blue; most vesicles filled with white kaolin, others filled with green nontronite.	53.0–58.0	9.5	15.3	24.1
			58.0–61.0	7.8	15.2	20.2
	53.5	Basalt, black-brown, semidecomposed.				
	61.0	Clay; residual from basalt, gray, light-blue, and brown.				
		Basalt.				

Drill hole logs and results of assays of the Excelsior deposit—Continued

Lithologic unit			Sample unit			
Formation symbols	Depth (feet)	Description	Length (feet)	Ignition loss (percent)	Available Fe_2O_3 (percent)	Available Al_2O_3 (percent)
Drill hole E–19. Coordinates 22,960N, 18,985E						
Qp	4.0	Soil and Palouse formation, gravel at base.	0.0–5.0			
			5.0–11.0	9.6	17.6	22.4
Tcl	6.0	Basalt, light-brownish, grayish, semidecomposed.	11.0–17.0	9.0	16.5	21.5
			17.0–22.0	6.9	17.3	16.9
	8.0	Basalt, light-gray, semidecomposed.	35.0–37.0	4.4	12.5	10.7
	10.0	Basalt, iron-brown, semidecomposed.	37.0–40.0	8.2	24.3	17.1
	16.0	Basalt, bluish-gray, semidecomposed; few amygdules of white kaolinite; green nontronite spots.	40.0–45.0	3.8	11.5	10.3
			45.0–50.0	5.0	16.1	12.1
			50.0–55.0	8.4	24.8	18.2
	22.0	Basalt; similar to that above; less decomposed, brownish; occasional hard spots.	55.0–59.0	9.8	18.0	23.2
			59.0–63.0	9.6	18.8	15.7
	22.5	Basalt, black, hard; nontronite streaks and spots.				
	26.0	Basalt, gray-black, slightly decomposed.				
	32.0	Basalt, black, hard; green nontronite in cracks and vesicles.				
	35.0	Basalt, brown and black, iron-stain.				
	37.0	Basalt, gray, partially decomposed.				
	45.0	Basalt, tannish- and greenish-gray, semidecomposed; nontronite specks uniformly distributed; hard spots. 37–40 ft strong limonite streaks. At 44 ft several small nontronite streaks.				
	49.5	Clay; residual from basalt; blue; scattered small amygdules of white kaolinite.				
	51.5	Limonite, red-brown.				
	52.0	Clay; residual from basalt, blue.				
	54.0	Basalt, green-brown, semidecomposed; hard spots.				
	63.0	Clay; residual from basalt; mottled; brown with disseminated black spots; top 6 in blue; many cracks and cavities filled or lined with yellow, palogonitic clays; blue clay borders the cracks for one-half inch grading into less altered black and brown clay.				
Drill hole E–21. Coordinates 22,025N, 13,500E						
Qp	26.5	Soil and Palouse formation, few quartz pebbles at base.	0.0–35.0			
Tcl	31.0	Basalt, green, vesicular, semidecomposed.				
	35.0	Basalt, black, semidecomposed; streaks and amygdules of green nontronite.				
Drill hole E–23. Coordinates 22,000N, 15,485E						
Qp	35.0	Soil and Palouse formation, granitic sand near base.	0.0–35.0			
			35.0–38.0	9.4	0.9	23.7
Tlu	38.0	Clay, transported, gray, slick, plastic.	43.0–49.0	10.8	14.3	26.3
	49.0	Clay, transported, yellow, plastic, some sandy; 1 ft white, plastic clay at base.	49.0–54.0	9.8	1.8	28.7
			54.0–60.0	9.8	2.1	28.4
Tcl	72.0	Clay; blue; plastic; residual from basalt; amygdules of white and tannish kaolinite; the color becomes darker blue and vesicles more abundant at 57 ft; clay grades downward to lighter blue and less vesicular; limonite streaks at 68 and 71 ft, occasional green stain, 65–72 ft.	60.0–65.0	10.0	2.2	28.9
			65.0–71.0	10.1	8.9	27.0
			71.0–77.0	10.5	12.4	26.7
			77.0–83.0	10.5	16.3	25.5
			83.0–90.0	10.0	23.0	22.5
			90.0–97.0	9.9	21.7	22.1
			97.0–102.0	6.2	10.9	15.8
	75.0	Clay; brown and blue; residual from basalt.				

Drill hole logs and results of assays of the Excelsior deposit—Continued

Lithologic unit			Sample unit			
Formation symbols	Depth (feet)	Description	Length (feet)	Ignition loss (percent)	Available Fe_2O_3 (percent)	Available Al_2O_3 (percent)
Drill hole E-23—Continued						
Tcl	82.0	Clay; mottled brown; residual from basalt; top foot has yellow palagonitic clay mixed with it.				
	102.0	Pillow basalt, decomposed and associated breccia; mixture of mottled brown clay from residual basalt, blue clay from residual basalt, limonite, and yellow palagonitic clay; about one-half to three-fourths is decomposed; yellow palagonitic clay at 93–97 ft; unweathered basalt and basalt glass at 97 ft to bottom.				
		Basalt.				
Drill hole E-24. Coordinates 21,960N, 16,480E						
Qp	23.0	Soil and Palouse formation, some gravel.	0.0–19.0			
	26.0	Gravel.	19.0–22.0	3.5	12.0	8.8
Tcu	28.0	Clay; brown, limonitic; residual from basalt.	22.0–26.0	5.4	5.8	15.8
	29.0	Clay; yellow, tuffaceous; residual from basalt.	26.0–32.0	10.5	25.0	21.6
	33.0	Clay; brown, limonitic; residual from basalt.				
	40.0	Clay; yellow; residual from basalt.				
	43.0	Basalt, black and brown; semidecomposed.				
	46.0	Tuff, basaltic glass, and ash.				
		Basalt.				
Drill hole E-25. Coordinates 21,940N, 17,470E						
Qp	32.0	Soil and Palouse formation.	0.0–32.0			
Tlu	36.0	Clay, transported, yellow, limonitic; lower 6 in. white.	32.0–35.0	10.5	19.6	23.2
			35.0–41.0	11.2	3.4	31.8
Tcl	39.0	Clay, dark; residual from basalt; blue-white kaolinite amygdules; light-tan and white clay seams.	41.0–47.0	10.8	2.4	32.1
			47.0–50.5	11.0	3.4	32.0
	46.0	Clay, light-blue-gray; residual from basalt.	50.5–52.5	8.4	20.9	18.6
	50.0	Clay, dark-blue; residual from basalt.				
	52.5	Clay, brown; residual from basalt.				
	55.0	Basalt, brown and black.				
Drill hole E-26. Coordinates 21,925N, 18,475E						
Qp	22.5	Soil and Palouse formation, some granitic gravel.	0.0–21.0			
			21.0–32.5	6.6	18.0	14.2
Tcu	32.5	Basalt, brownish-black, semidecomposed; dark gray at bottom. Joints filled with reddish brown.				
		Basalt.				
Drill hole E-27. Coordinates 21,015N, 12,980E						
Qp	23.5	Soil and Palouse formation.	0.0–24.0			
Tcl	24.0	Basalt, semidecomposed.				
		Basalt.				

Drill hole logs and results of assays of the Excelsior deposit—Continued

Lithologic unit			Sample unit			
Formation symbols	Depth (feet)	Description	Length (feet)	Ignition loss (percent)	Available Fe_2O_3 (percent)	Available Al_2O_3 (percent)
Drill hole E-28. Coordinates 21,015N, 13,980E						
Qp	13.0	Soil and Palouse formation.	0.0–12.0			
Tcl	15.0	Clay, blue-gray, motted; residual from basalt; white amygdules.	12.0–14.0	10.0	2.7	29.0
			14.0–18.0	11.0	1.5	31.7
	16.0	Clay, blue; residual from basalt; white amygdules.	18.0–22.0	11.1	1.6	32.3
			22.0–26.0	9.2	8.0	25.6
	21.0	Clay, light-blue-gray, residual from basalt; white amygdules, vesicular.				
	25.0	Clay, brown, tuffaceaus, residual from basalt.				
	29.5	Basalt, brown; semidecomposed; hard near base.				
		Basalt.				
Drill hole E-29. Coordinates 21,000N, 14,965E						
Qp	14.0	Soil and Palouse formation.	0.0–13.5			
Tcl	20.0	Clay; blue-gray, residual from basalt.	13.5–17.5	10.1	7.2	28.2
	30.0	Basalt, dark blue, vesicular, semidecomposed, iron-streaked.	17.5–20.0	8.7	13.5	22.0
			20.0–24.0	5.1	9.6	14.7
	36.0	Clay; greenish-yellow, tuffaceous; residual from basalt; some round pieces of vesicular basalt.	31.0–36.0	8.0	13.0	21.4
	44.0	Basalt, partly decomposed.				
		Basalt.				
Drill hole E-30. Coordinates 20,985N, 15,955E						
Qp	25.0	Gravel, granitic and basaltic.	0.0–40.0			
	40.0	Palouse formation.				
Tcu		Basalt.				
Drill hole E-31. Coordinates 20,970N, 16,960E						
Qp	25.0	Soil and Palouse formation.	0.0–32.0			
Tcu	28.0	Basalt, semidecomposed, black.				
	32.0	Basalt.				
Drill hole E-32. Coordinates 20,950N, 17,955E						
Qp	23.0	Soil and Palouse formation.	0.0–25.0			
Tcu	25.0	Basalt, semidecomposed, vesicular, iron-stained.	25.0–30.0	9.6	12.6	23.2
			30.0–36.0	4.3	11.9	10.1
	27.0	Basalt, gray; semidecomposed; iron-stained kaolin amydgules.	36.0–39.0	6.5	14.8	16.6
	30.0	Basalt, black and dark gray; semidecomposed; yellow and olive green nontronite amygdules; iron-stained near top.				
	35.0	Basalt, gray, partly altered, vesicular.				
	40.0	Basalt, black and dark gray, semidecomposed; yellow and olive green nontronite amygdules; iron-stained near top.				
		Basalt.				

Drill hole logs and results of assays of the Excelsior deposit—Continued

Lithologic unit			Sample unit			
Formation symbols	Depth (feet)	Description	Length (feet)	Ignition loss (percent)	Available Fe_2O_3 (percent)	Available Al_2O_3 (percent)
		Drill hole E-34. Coordinates, 20,380N, 13,470E				
Qp	13.5	Soil and Palouse formation.	0.0–13.0			
Tcl	15.0	Clay; blue-gray residual from basalt.	13.0–20.0	11.7	2.2	32.2
	18.5	Clay; dark-blue residual from basalt.	20.0–28.0	11.1	8.6	28.9
	24.0	Clay; light-gray, iron-stained residual from basalt.	28.0–35.0	11.1	8.3	29.6
			35.0–41.0	10.3	11.7	26.6
	43.0	Clay; blue and tan, tuffaceous residual from basalt.	41.0–50.0	10.4	13.5	25.5
			50.0–56.0	10.1	11.3	26.1
	63.0	Basalt, semidecomposed; mottled brown, tan tuffaceous clay.	56.0–63.0	8.2	17.9	19.2
		Basalt.				
		Drill hole E-35. Coordinates, 20,385N, 14,440E				
Qp	19.0	Soil and Palouse formation.	0.0–21.0			
Tlu	27.0	Clay, transported, gray and purplish; gray clayey sand and quartz gravel at base.	21.0–24.0	6.3	3.1	16.2
			24.0–31.0			
Tcl	30.0	Clay; blue-gray, vesicular residual from basalt.				
	31.0	Basalt, semidecomposed brown-black.				
		Basalt.				
		Drill hole E-36. Coordinates, 20,075N, 15,450E				
Qp	9.0	Soil and Palouse formation, some sand and gravel.	0.0–10.0			
			10.0–16.0	7.2	18.3	16.5
Tcu	11.0	Basalt, black and gray, semidecomposed.	16.0–20.0	7.5	16.9	18.3
	20.0	Basalt, semidecomposed, brown tuff and volconic breccia; olive nontronite filling vesicules.	20.0–30.0			
	30.0	Basalt, nontronite spots.				
		Basalt.				
		Drill hole E-37. Coordinates, 20,000N, 16,450E				
Qp	16.0	Soil and Palouse formation.	0.0–17.0			
Tcu	17.0	Basalt, gray, semidecomposed; green nontronite spots.				
		Basalt.				
		Drill hole E-40. Coordinates, 22,970N, 17,490E				
Qp	2.0	Soil and Palouse formation.	0.0–1.0			
Tcl	7.0	Clay; residual from basalt; blue-gray; mottled with white kaolinite spots on blue background; limonite streak at base.	1.0–7.0	11.4	3.2	31.6
			7.0–12.0	11.2	6.7	30.9
			12.0–17.0	11.4	7.2	30.8
			17.0–22.0	10.6	22.6	23.8
	28.0	Clay; residual from basalt; light-tan and blue-gray; limonite streaks and stains. 17–26 feet, iron is very strong.	22.0–28.0	10.4	18.0	23.6
			28.0–35.0	10.2	17.9	23.7
			35.0–40.0	9.6	21.0	21.0
	39.0	Clay; residual from basalt; dark-blue; white kaolinite amygdules; several limonite bands and stains; light blue from 37 feet on.	40.0–45.0	9.2	15.4	21.2
			45.0–50.0	5.9	12.9	14.2
			50.0–56.0	6.5	16.3	14.1
			56.0–63.0	7.5	17.9	17.3
	49.0	Clay; residual from basalt; tannish and greenish gray; occasional hard spots.	63.0–74.0			

Drill hole logs and results of assays of the Excelsior deposit—Continued

Lithologic unit			Sample unit			
Formation symbols	Depth (feet)	Description	Length (feet)	Ignition loss (percent)	Available Fe_2O_3 (percent)	Available Al_2O_3 (percent)
Drill hole E–40—Continued						
Tcl	56.0	Basalt, semidecomposed, blue-black, contains a few yellow kaolin amygdules, scattered hard spots, limonite, 6-in beds of semidecomposed palagonite at 51 and 54 ft.				
	63.0	Palagonite and vesicular ash; mostly semidecomposed; many are glassy ash blocks, hard brown basalt, at 58 feet; semidecomposed, brown basalt at 61 feet.				
	64.5	Basalt, brown and black, hard; contains green nontronite particles;.				
	66.5	Basalt, semihard, black and gray, contains white kaolinite and green nontronite particles.				
	71.0	Basalt, semidecomposed, gray and brown, amygdaloidal; contains amygdules of white kaolinite and some green nontronite, hard black basalt, and palagonite.				
	74.0	Basalt much like that at 66.5–71.0 feet, but less decomposed and more black basalt.				
Drill hole E–41. Coordinates, 19,010N, 13,950E						
Qp	4.5	Soil and Palouse formation.	0.0– 6.0			
Tcu	5.0	Pillow basalt, slight altered.				
	6.0	Pillow basalt, hard, black, glass; with tan palagonite.				
		Basalt.				
Drill hole E–42. Coordinates, 19,000N, 14,925E						
Qp	5.5	Soil and Palouse formation.	0.0–29.0			
Tcu	19.0	Volcanic tuff, ash, and bombs, tan; black glass blocks with yellow palagonite.				
	29.0	Basalt, black.				
		Basalt.				
Drill hole E–43. Coordinates, 18,975N, 15,985E						
Qp	18.0	Soil and Palouse formation.	0.0–19.0			
Tcu	25.0	Basalt, semidecomposed, and mottled brown and black vesicular basalt and dark-gray basalt with some palagonite, limonite streaks.	19.0–25.0	9.9	17 9	23.2
			25.0–29.0	10.0	6.6	27.5
			29.0–35.0	6.8	10.2	17.4
			35.0–40.0	3.6	14.3	7.6
Tcl	29.0	Clay; blue-gray, residual from basalt; with tan kaolinite amygdules, dark-gray clay in cracks.				
	40.0	Basalt, semidecomposed, mostly brown and gray; some dark-blue and black, few vesicules filled with tan kaolinite, most vesicules unfilled.				

Drill hole logs and results of assays of the Excelsior deposit—Continued

Lithologic unit			Sample unit			
Formation symbols	Depth (feet)	Description	Length (feet)	Ignition loss (percent)	Available Fe_2O_3 (percent)	Available Al_2O_3 (percent)
		Drill hole E-45. Coordinates, 17,960N, 16,170E				
Qp	7.0	Soil and Palouse formation.	0.0–40.0			
Tcu	10.0	Basalt, semidecomposed, brown and blue-black, amygduloidal.				
	13.0	Tuff, semidecomposed, brown, iron-stained.				
	18.0	Basalt, semidecomposed, mottled brown and dark-blue vesicules.				
	22.5	Tuff and volcanic ash, semidecomposed, tan.				
	25.0	Basalt, semidecomposed, dark brown; blue and yellow clay stringers.				
	34.0	Tuff and volcanic ash, semidecomposed, brown.				
	36.0	Basalt, semidecomposed, brown and blue; contains olive-green nontronite stringers.				
	40.0	Tuff, and volcanic ash, semidecomposed, red-brown.				
		Basalt.				
		Drill hole E-46. Coordinates 25,045N, 13,045E				
Qp	59.0	Soil and Palouse formation. Quartz gravel in last 3 ft.	0.0–78.0			
Tlu	78.0	Clay, transported, gray, gravel and silt.				
		Drill hole E-47. Coordinates 18,190N, 14,040E				
Qp	22.0	Soil and Palouse formation.	0.0–21.0			
Tcl	41.0	Clay; residual from basalt; blue and gray; contains white anygdules.	21.0–30.0	10.0	10.9	25.9
			30.0–36.0	9.6	14.3	24.4
	45.0	Clay; residual from basalt; tan, tuffaceous.	36.0–42.0	7.7	10.9	19.3
			42.0–46.0	9.4	17.7	21.7
	54.0	Basalt, semidecomposed, gray and brown.	46.0–50.0	4.1	8.9	11.3
		Basalt.				
		Drill hole E-48. Coordinates 23,935N, 19,500E				
Qp	5.0	Soil and Palouse formation.	0.0– 4.0			
Tcu	21.0	Clay, brown and gray, tuffaceous; residual from basalt; contains a few hard spots.	4.0–10.0	6.6	18.0	15.0
			10.0–16.0	8.3	25.2	16.6
			16.0–21.0	8.0	17.9	16.6
	37.0	Clay, tan and some blue, tuffaceous; residual from basalt.	21.0–31.0	6.6	12.8	13.1
			31.0–40.0	6.8	6.5	18.1
	47.0	Clay, tan, tuffaceous, residual from basalt.	40.0–46.0	6.8	6.3	12.2
			46.0–52.0			
Tcl	52.0	Basalt, black, hard.				
		Drill hole E-49. Coordinates 24,700N, 20,110E				
Qp	2.0	Soil and Palouse formation, some gravel.	0.0– 2.0			
Tcl	7.0	Clay, green, blue, gray-green; residual from basalt; ironstained near base.	2.0– 8.0	10.6	8.3	28.5
			8.0–12.0	4.6	11.7	11.9
	14.0	Basalt, green and gray, amygduloidal; semidecomposed.	12.0–14.0			
		Basalt.				

Drill hole logs and results of assays of the Excelsior deposit—Continued

Lithologic unit			Sample unit			
Formation symbols	Depth (feet)	Description	Length (feet)	Ignition loss (percent)	Available Fe_2O_3 (percent)	Available Al_2O_3 (percent)
Drill hole E-50. Coordinates 17,290N, 25,425E						
Qp	33.5	Soil and Palouse formation.	0.0–35.0			
Tcu	35.0	Basalt, dark-green-gray, hard.				
		Basalt.				
Drill hole M-8. Coordinates 25,900N, 15,850E						
Tlu	5.0	Clay, transported, gray and yellow, silty.	0.0– 5.0	6.2	2.0	17.4
	10.0	Do.	5.0–10.0	7.0	1.6	19.8
	25.0	Clay, transported, yellow, sandy.	10.0–25.0	6.3	3.1	15.9
	35.0	Do.	25.0–35.0	6.6	3.6	17.3
Drill hole M-9. Coordinates 25,870N, 15,955E						
Qp	3.0	Soil and Palouse formation.	0.0– 3.0			
Tcl	13.0	Clay; residual from basalt; brown and gray.	3.0–13.0	9.7	21.6	22.3
			13.0–30.0	10.2	23.1	22.8
	30.0	Clay; residual from basalt; brown.				
Drill hole M-10. Coordinates 24,035N, 15,480E						
Qp	3.0	Soil and Palouse formation.	0.0– 3.0			
Tlu	8.0	Clay, transported, yellow.	3.0– 8.0	9.9	9.7	23.5
Tcl	13.0	Clay; residual from basalt; blue-gray.	8.0–13.0	9.0	2.0	26.4
Drill hole M-11A. Coordinates 25,910N, 15,725E						
Qp	10.0	Soil and Palouse formation.	0.0–10.0	3.6	4.8	7.5
	15.0	Do.	10.0–15.0	3.5	4.1	9.2
	16.0	Gravel.	15.0–16.0			
Drill hole M-11B. Coordinates 26,075N, 15,460E						
Qp	10.0	Soil and Palouse formation.	0.0–10.0			
		Gravel.				
Drill hole M-12. Coordinates 22,985N, 15,410E						
Qp	6.0	Soil and Palouse formation.	0.0– 6.0			
Tlu	9.0	Clay, transported, yellow.	6.0– 9.0	10.2	11.7	24.1
Tcl	19.0	Clay; residual from basalt; blue-gray.	9.0–19.0	11.4	2.3	31.7
	32.0	Do.	19.0–32.0	10.0	2.0	32.0
Drill hole M-13. Coordinates 24,140N, 17,045E						
Qp	2.5	Soil and Palouse formation.	0.0– 2.5			
	7.5	Gravel.	2.5– 7.5	3.7	5.4	7.8
Tcu	12.5	Clay; residual from basalt; yellow, pink, and gray; contains some unweathered basalt gravel.	7.5–12.5	3.6	6.9	8.5
			12.5–17.5	10.2	3.4	28.2
			17.5–22.5	7.2	5.3	19.7
Tcl	17.5	Clay; residual from basalt; blue-gray.	22.5–24.5	5.3	6.9	14.5
	22.5	Do.				
	24.5	Do.				

Drill hole logs and results of assays of the Excelsior deposit—Continued

Lithologic unit			Sample unit			
Formation symbols	Depth (feet)	Description	Length (feet)	Ignition loss (percent)	Available Fe_2O_3 (percent)	Available Al_2O_3 (percent)
Drill hole M–14. 22,970N, 16,675E						
Qp	7.5	Soil and Palouse formation.	0.0–7.5			
Tcl	17.5	Clay; residual from basalt; blue-gray.	7.5–17.5	11.0	2.0	31.0
	24.5	Clay; residual from basalt; blue-gray; mottled white with kaolinite amygdules.	17.5–24.5	9.7	5.9	25.3
Drill hole M–15A. Coordinates 20,575N, 16,305E						
Qp	10.0	Soil and Palouse formation. Gravel.	0.0–10.0			
Drill hole M–15B. Coordinates 20,700N, 16,330E						
Qp	10.0	Soil and Palouse formation. Gravel.	0.0–10.0			
Drill hole M–15C. Coordinates 21,330N, 16,070E						
Qp	5.0	Soil and Palouse formation. Gravel, coarse.	0.0–5.0			
Drill hole M–15D. Coordinates 21,840N, 16,030E						
Qp	1.0	Soil.	0.0–1.0			
	5.5	Palouse formation.	1.0–5.5	5.7	6.1	14.5
	10.0	Do.	5.5–10.0	3.6	4.9	8.3
	16.0	Do.	10.0–16.0			
Drill hole M–16. Coordinates 23,580N, 17,875E						
Qp	3.5	Soil and Palouse formation.	0.0–3.5			
Tcl	8.5	Clay; residual from basalt; blue and yellow.	3.5–8.5	10.3	5.9	27.5
	13.5	Do.	8.5–13.5	10.6	8.5	28.1
	17.0	Clay; residual from basalt; brown and blue-gray.	13.5–17.0	8.7	17.2	20.2
Drill hole M–17. Coordinates, 22,530N, 17,330E						
Qp	12.0	Soil and Palouse formation.	0.0–12.0			
Tcl	15.0	Clay; residual from basalt; blue-gray and tan.	12.0–15.0	9.9	10.0	25.0
			15.0–18.5	9.5	13.8	23.6
	18.5	Do.	18.5–22.0	8.6	20.5	17.5
	22.0	Clay; residual from basalt; brown and tan.	22.0–27.0	8.9	20.4	19.1
	27.0	Clay; residual from basalt; brown, tan, and blue.				
Drill hole M–18. Coordinates, 25,055N, 18,205E						
Qp	5.0	Soil and Palouse formation.	0.5–5.0			
Tcl	10.0	Clay; residual from basalt; blue-gray and yellow.	5.0–10.0	8.6	14.9	20.4
			10.0–19.0	7.9	20.7	17.2
	19.0	Clay; residual from basalt; brown and blue-gray.	19.0–21.0	6.4	23.6	12.2
	21.0	Clay; residual from basalt; greenish-brown.				

Drill hole logs and results of assays of the Excelsior deposit—Continued

Lithologic unit			Sample unit			
Formation symbols	Depth (feet)	Description	Length (feet)	Ignition loss (percent)	Available Fe_2O_3 (percent)	Available Al_2O_3 (percent)
Drill hole M-19. Coordinates, 22,950N, 18,250E						
Qp	13.0	Soil and Palouse formation.	0.0–13.0			
Drill hole M-20. Coordinates, 21,650N, 16,660E						
Qp	2.0	Soil and Palouse formation.	0.0– 2.0			
Tcl	5.5	Clay; residual from basalt; blue-gray.	2.0– 5.5	10.4	5.1	27.5
	13.0	Do.	5.5–13.0	11.4	5.1	29.6
	23.0	Clay; residual from basalt; greenish-brown.	13.0–23.0	8.1	9.7	21.1
Drill hole M-21. Coordinates, 23,950N, 18,490E						
Qp	16.0	Soil and Palouse formation.	0.0–16.0			
Drill hole M-22. Coordinates, 24,330N, 17,760E						
Qp	7.0	Soil and Palouse formation.	0.0– 7.0			
Tcl	12.0	Clay; residual from basalt; brownish-black.	7.0–12.0			
	19.0	Do.	12.0–19.0	6.1	12.0	14.5
Drill hole M-23. Coordinates, 25,825N, 16,970E						
Qp	7.0	Soil and Palouse formation.	0.0– 7.0			
	17.0	Palouse formation; mixed basalt and granodiorite residual clay.	7.0–17.0	6.3	11.3	15.0
KJg	22.0	Clay; residual from granodiorite; yellowish-gray and white.	17.0–22.0	4.7	4.1	11.4
Drill hole M-24. Coordinates, 24,795N, 14,795E						
Qp	5.0	Soil and Palouse formation.	0.0– 5.0			
Tcl	10.5	Clay; residual from basalt; blue and brown.	5.0–10.5	9.8	12.8	25.1
			10.5–20.5	9.6	18.2	18.4
	20.5	Clay; residual from basalt; brownish-black; spotted green and blue-gray.	20.5–28.0	8.4	16.4	21.6
	28.0	Clay; residual from basalt; brown; contains greenish-yellow amygdules.				
Drill hole M-25. Coordinates, 21,655N, 14,930E						
Qp	6.0	Soil and Palouse formation.	0.0– 6.0			
	17.0	Palouse formation.	6.0–17.0	3.9	4.3	8.0
Drill hole M-26A. Coordinates, 20,190N, 15,085E						
Qp	9.0	Soil and Palouse formation.	0.0– 9.0			
Drill hole M-26B. Coordinates, 20,345N, 15,870E						
Qp	9.0	Soil and Palouse formation.	0.0– 9.0			
Tcl	18.0	Clay; residual from basalt; blue-gray and brown.	9.0–18.0	11.5	5.4	24.0

Drill hole logs and results of assays of the Excelsior deposit—Continued

Lithologic unit			Sample unit			
Formation symbols	Depth (feet)	Description	Length (feet)	Ignition loss (percent)	Available Fe_2O_3 (percent)	Available Al_2O_3 (percent)
Drill hole M-27. Coordinates, 17,960N, 14,585E						
Qp	14.0	Soil and Palouse formation.	0.0–14.0			
	19.0	Palouse formation and weathered basalt.	14.0–19.0	8.0	10.8	11.3
	22.0	Do.	19.0–22.0	9.0	4.9	15.4
Tcu	23.5	Clay; residual from basalt; blue-gray.	22.0–23.5	7.2	4.9	18.2
	28.5	Do.	23.5–28.5	5.1	3.9	15.4
Drill hole M-28. Coordinates, 19,710N, 15,740E						
Qp	3.0	Soil and Palouse formation.	0.0– 3.0			
Tcu	7.0	Clay; residual from basalt; tan and blue.	3.0– 7.0	11.9	4.8	31.3
	12.0	Clay; residual from basalt; yellow and brown; contains some basalt glass.	7.0–12.0	11.3	22.5	25.1
			12.0–19.0	11.3	17.1	25.6
	19.0	Clay; residual from basalt; tan.	19.0–20.0			
Tcl	20.0	Clay; residual from basalt; blue-gray.	20.0–31.0	11.0	11.5	29.0
	31.0	Do.	31.0–37.0	9.0	15.1	21.8
	37.0	Clay; residual from basalt; blue, green, and tan.				
Drill hole M-29. Coordinates, 25,620N, 16,290E						
Qp	4.0	Soil and Palouse formation.	0.0– 4.0			
Tcu	12.0	Clay; residual from basalt; brown and tan.	4.0–12.0	8.9	19.9	18.7
Drill hole M-30						
Qp	13.0	Soil and Palouse formation.	0.0–13.0			
Tcl	18.0	Clay; residual from basalt; blue-gray.	13.0–18.0	10.3	3.1	28.6
	28.0	Clay; residual from basalt; blue-gray and some yellow.	18.0–28.0	7.6	9.0	19.2
Drill hole M-31. Coordinates, 16,550N, 14,140E						
Qp	27.0	Soil and Palouse formation.	0.0–27.0			
	29.0	Palouse formation.	27.0–29.0	6.8	11.5	15.5
Tcu	31.0	Clay; residual from basalt; blue-gray and green.	29.0–31.0	7.9	12.3	18.4
			31.0–34.0	7.0	13.3	17.1
	34.0	Do.	34.0–36.0	8.4	10.3	21.4
	36.0	Clay; residual from basalt; blue-gray.	36.0–37.0	7.9	21.3	18.0
	37.0	Clay; residual from basalt; iron-stained.				
Drill hole M-32. Coordinates, 19,715N, 13,830E						
Qp	9.5	Soil and Palouse formation.	0.0– 9.5			
Tcl	14.5	Clay; residual from basalt; iron-stained.	9.5–14.5	10.5	15.9	25.7
	18.5	Clay; residual from basalt; brown and blue-gray.	14.5–18.5	10.8	16.3	25.9
			18.5–22.5	10.5	13.5	25.3
	22.5	Clay; residual from basalt; yellow and blue.				
Drill hole M-33. Coordinates, 17,495N, 16,490E						
Qp	6.0	Soil and Palouse formation.	0.0– 6.0			
Tcu	11.0	Clay; residual from basalt; brown and some yellow.	6.0–11.0	9.3	15.1	22.1

Drill hole logs and results of assays of the Excelsior deposit—Continued

Lithologic unit			Sample unit			
Formation symbols	Depth (feet)	Description	Length (feet)	Ignition loss (percent)	Available Fe_2O_3 (percent)	Available Al_2O_3 (percent)
Drill hole M-34. Coordinates, 20,375N, 14,240E						
Qp	8.0	Soil and Palouse formation.	0.0– 8.0			
Drill hole M-35. Coordinates 22,975N, 23,250E						
Qp	1.0	Soil and Palouse formation.	0.0– 1.0			
Tcl	6.0	Clay; residual from basalt; gray; some iron staining.	1.0– 6.0	9.3	16.1	21.0
	11.0	Do.	6.0–11.0	9.3	20.3	19.6
		Basalt, semidecomposed.				
Drill hole M-36. Coordinates 22,905N, 23,800E						
Qp	13.0	Soil and Palouse formation.	0.0–13.0			
Tcl		Basalt, semidecomposed.				
Drill hole M-37. Coordinates 22,925N, 24,880E						
Tlu	12.0	Sand, transported.	0.0–12.0			
Drill hole M-38						
Tcl	5.0	Clay; residual from basalt; blue and gray, some iron staining.	0.0– 5.0	9.6	9.4	26.0
	10.0	Clay; residual from basalt; blue and gray.	5.0–10.0	10.2	7.5	27.6
	13.0	Do.	10.0–13.0	9.1	13.5	23.5
		Basalt.				
Drill hole M-39. Coordinates 23,665N, 23,755E						
Qp	5.0	Soil and Palouse formation.	0.0– 5.0			
Tcl	10.0	Clay; residual from basalt; blue-gray; contains some iron.	5.0–10.0	12.0	6.3	31.5
	15.0	Clay; residual from basalt; blue-gray.	10.0–15.0	11.1	4.2	30.2
	20.0	Clay; residual from basalt; light gray.	15.0–20.0	11.2	2.7	32.1
	24.0	Do.	20.0–24.0	11.2	3.4	31.4
	26.0	Clay; residual from basalt; light gray; heavily iron-stained.	24.0–26.0	11.0	5.4	29.6
	31.0	Clay; residual from basalt; gray; iron-stained.	26.0–31.0	10.0	4.8	29.8
	36.0	Clay; residual from basalt; gray; iron-stained.	31.0–36.0	10.6	7.1	28.6
	38.0	Basalt, heavily iron-stained, semidecomposed.	36.0–38.0			
Drill hole M-40. Coordinates 24,925N, 23,100E						
Tcl	5.0	Clay; residual from basalt; blue-gray.	0.0– 5.0	9.8	3.6	26.2
	8.0	Do.	5.0– 8.0	10.8	2.1	31.1
	11.0	Clay; residual from basalt; blue-gray, some iron staining.	8.0–11.0	11.2	3.1	32.0
	14.0	Clay; residual from basalt; blue, heavily iron-stained.	11.0–14.0	11.6	16.6	27.2
		Basalt, semidecomposed.				

Drill hole logs and results of assays of the Excelsior deposit—Continued

Lithologic unit			Sample unit			
Formation symbols	Depth (feet)	Description	Length (feet)	Ignition loss (percent)	Available Fe_2O_3 (percent)	Available Al_2O_3 (percent)
Drill hole M-41. Coordinates 25,480N, 23,220E						
Qp	12.0	Soil and Palouse formation.	0.0–12.0			
Tlu	14.0	Gravel and clay, transported.	12.0–14.0			
Tcl	17.0	Clay; residual from basalt; blue; iron-stained.	14.0–17.0	10.8	10.8	27.0
			17.0–21.0	11.0	4.0	30.4
	21.0	Clay; residual from basalt; blue; some iron staining.	21.0–26.0	11.0	2.2	32.2
			26.0–31.0	10.7	7.8	27.5
	26.0	Clay; residual from basalt; light gray; little iron staining.	31.0–36.0	11.7	1.2	32.8
			36.0–41.0	10.4	1.7	30.0
	31.0	Clay; residual from basalt; blue; and yellow tuffaceous clay.	41.0–46.0	10.2	1.3	29.3
			46.0–51.0	9.8	2.4	28.8
	36.0	Do.				
	41.0	Do.				
	46.0	Do.				
	51.0	Do.				
Drill hole M-42. Coordinates 26,410N, 23,145E						
Qp	2.0	Soil and Palouse formation.	0.0– 2.0			
	3.0	Gravel.	2.0– 3.0			
Tcl	8.0	Clay; residual from basalt; blue-gray.	3.0– 8.0	11.7	3.3	31.7
	12.0	Do.	8.0–12.0	10.5	5.3	29.7
	16.0	Clay; residual from basalt; light-brown; may have some transported clay mixed in.	12.0–16.0	10.2	5.0	28.2
			16.0–21.0	11.4	1.6	31.8
			21.0–26.0	11.2	1.4	31.6
	21.0	Clay; residual from basalt, dark-blue.	26.0–31.0	10.5	2.5	30.3
	26.0	Clay; residual from basalt; blue.	31.0–36.0	10.5	2.5	31.1
	31.0	Do.	36.0–41.0	10.9	2.0	31.6
	36.0	Clay; residual from basalt; blue; and yellow tuffaceous clay; may have some transported clay mixed in.	41.0–46.0	10.6	2.8	29.9
			46.0–49.0	9.6	4.5	26.9
	41.0	Do.				
	46.0	Do.				
	49.0	Do.				
Drill hole M-43. Coordinates 25,290N, 23,855E						
Qp	1.0	Soil and Palouse formation.	0.0–14.0			
	6.0	Palouse formation and gravel.	14.0–15.0	12.1	2.2	34.0
Tlu	10.0	Clay, transported, sandy, micaceous.	15.0–17.0			
	14.0	Do.	17.0–21.0	10.8	4.7	30.5
	15.0	Clay, transported.	21.0–26.0	10.8	3.4	30.9
Tcl	17.0	Clay; residual from basalt; blue.	26.0–31.0	11.0	2.2	31.8
	21.0	Clay; residual from basalt; blue, contains some iron.				
	26.0	Clay; residual from basalt; blue; contains a little iron.				
	31.0	Do.				
Drill hole M-44. Coordinates 26,775N, 24,470E						
Qp	1.0	Soil and Palouse formation.	0.0–12.0			
Tlu	6.0	Clay, transported, white, micaceous.	12.0–17.0	11.2	4.8	30.4
	12.0	Clay, transported, white, sandy layers.	17.0–22.0	11.4	2.5	31.7
Tcl	17.0	Clay; residual from basalt; blue; iron-stained; some transported clay at top.	22.0–27.0	11.2	1.9	31.9
			27.0–32.0	11.0	2.7	31.7
	22.0	Clay; residual from basalt; light gray.	32.0–36.0	11.3	3.6	32.2
	27.0	Clay; residual from basalt; blue and white.	36.0–41.0	10.8	2.0	31.6
			41.0–44.0	10.8	6.1	28.5
	32.0	Clay; residual from basalt; blue and white.	44.0–47.0	8.8	12.4	22.8
	36.0	Clay; residual from basalt; white and blue, some iron-staining.				
	41.0	Clay; residual from basalt, blue.				
	44.0	Do.				
	47.0	Clay; residual from basalt; blue and brown; iron-stained.				
		Basalt, semidecomposed.				

Drill hole logs and results of assays of the Excelsior deposit—Continued

Lithologic unit			Sample unit			
Formation symbols	Depth (feet)	Description	Length (feet)	Ignition loss (percent)	Available Fe_2O_3 (percent)	Available Al_2O_3 (percent)
Drill hole M-45. Coordinates 25,870N, 24,575E						
Qp	13.0	Soil and Palouse formation.	0.0–13.0			
Tcl		Basalt, semidecomposed.				
Drill hole M-46. Coordinates 25,755N, 24,925E						
Qp	16.0	Soil and Palouse formation.	0.0–16.0			
Tcl	21.0	Clay; residual from basalt; gray, iron-stained.	16.0–21.0	8.4	11.8	21.1
		Basalt, semidecomposed.				
Drill hole M-47. Coordinates 25,880N, 25,910E						
Tlu	11.0	Clay, transported, white; micaceous layers.	0.0–11.0			
			11.0–17.0	11.0	3.2	30.4
Tcl	17.0	Clay; residual from basalt; blue.	17.0–22.0	11.3	2.2	32.5
	22.2	Do.	22.0–27.0	10.6	1.6	32.1
	27.0	Do.	27.0–30.0	7.0	2.2	21.8
	30.0	Clay; residual from basalt; gray; semi-decomposed basalt.				
		Basalt, semidecomposed.				
Drill hole M-48. Coordinates 26,140N, 25,550E						
Qp	5.0	Soil and Palouse formation.	0.0–17.0			
Tlu	17.0	Clay, transported, heavily iron-stained.				
Tcl		Basalt, semidecomposed.				
Drill hole M-49. Coordinates 24,610N, 23,725E						
Qp	11.0	Soil and Palouse formation.	0.0–11.0			
Tcl	16.0	Clay; residual from basalt; blue-gray; some iron staining.	11.0–16.0	10.6	6.8	27.8
			16.0–21.0	10.7	6.1	22.0
	21.0	Clay; residual from basalt; gray; iron-stained.	21.0–26.0	10.8	2.9	31.7
			26.0–31.0	10.2	4.5	29.9
	26.0	Clay; residual from basalt; gray-blue.	31.0–36.0	10.2	4.6	29.5
	31.0	Clay; residual from basalt; gray-blue; some iron-staining.	36.0–42.0	9.4	9.2	26.6
	36.0	Do.	42.0–43.0			
	42.0	Clay; residual from basalt; gray-blue; iron-stained.				
	43.0	Clay; residual from basalt; heavily iron-stained; and semidecomposed basalt.				
Drill hole M-50. Coordinates 24,170N, 24,120E						
Qp	2.0	Soil and Palouse formation.	0.0– 2.0			
Tcl	6.0	Clay; residual from basalt; gray; heavily iron-stained.	2.0– 6.0	10.8	6.0	29.8
			6.0– 9.0	11.2	6.8	30.2
	9.0	Clay; residual from basalt; gray; some iron staining.	9.0–15.0	10.0	22.3	23.4
			15.0–21.0	9.5	10.4	24.6
	15.0	Clay; residual from basalt; gray; iron-stained.	21.0–26.0	7.6	11.5	18.8
	21.0	Clay; residual from basalt; green-blue; some iron staining.				
	26.0	Clay; residual from basalt; green-gray; semidecomposed basalt.				

Drill hole logs and results of assays of the Excelsior deposit—Continued

Lithologic unit			Sample unit			
Formation symbols	Depth (feet)	Description	Length (feet)	Ignition loss (percent)	Available Fe_2O_3 (percent)	Available Al_2O_3 (percent)
Drill hole M-51. Coordinates 23,590N, 22,840E						
Qp	2.0	Soil and Palouse formation.	0.0–2.0			
Tcl	7.0	Clay; residual from basalt; blue; tuffaceous iron-stained clay.	2.0–7.0	7.7	8.3	20.5
	12.0	Do.	7.0–12.0	9.1	13.6	22.6
	17.0	Clay; residual from basalt; blue.	12.0–17.0	9.0	10.4	23.8
	22.0	Clay; residual from basalt; blue; and semidecomposed iron-stained basalt; water at 21 feet.	17.0–22.0	8.6	23.7	17.8
			22.0–27.0	7.3	30.2	13.8
	27.0	Basalt, semidecomposed, iron-stained.	27.0–32.0	6.8	26.0	13.8
	32.0	Basalt, semidecomposed, ironstained; spots of green nontronite.	32.0–36.0	5.8	14.9	15.1
	36.0	Do.				
Drill hole M-52. Coordinates 23,545N, 24,190E						
Qp	2.0	Soil and Palouse formation.	0.0–15.0			
Tcl	15.0	Clay; residual from basalt; blue; heavily iron stained.	15.0–21.0	10.5	11.0	28.2
			21.0–25.0	10.4	9.9	27.5
	21.0	Clay; residual from basalt, blue, brown, and gray; contains some tuffaceous heavily iron-stained clay.	25.0–30.0	9.8	13.0	25.6
	25.0	Clay; residual from basalt; green-brown and purple, amygduloidal, heavily iron-stained.				
	30.0	Clay; residual from basalt; blue-gray; contains some semidecomposed basalt.				
Drill hole M-53. Coordinates 23,510N, 24,760E						
Qp	11.0	Soil and Palouse formation.	0.0–28.0			
Tlu	20.0	Sand, transported, micaceous.				
	28.0	Sand, transported; some white clay layers.				
		Sand, transported.				
Drill hole M-54. Coordinates 24,350N, 25,645E						
Qp	10.0	Soil and Palouse formation.	0.0–11.0			
	11.0	Gravel.				
Tcu		Basalt?				
Drill hole M-55. Coordinates 23,535N, 25,790E						
Qp	7.0	Soil and Palouse formation.	0.0–7.0			
Tcu		Basalt?				
Drill hole M-56. Coordinates 24,270N, 25,120E						
Qp	14.0	Soil and Palouse formation.	0.0–26.0			
Tlu	26.0	Clay and gravel, transported, micaceous.				

Drill hole logs and results of assays of the Excelsior deposit—Continued

Lithologic unit			Sample unit			
Formation symbols	Depth (feet)	Description	Length (feet)	Ignition loss (percent)	Available Fe_2O_3 (percent)	Available Al_2O_3 (percent)
Drill hole M-57. Coordinates 24,340N, 22,590E						
Qp	2.0	Soil and Palouse formation.	0.0- 2.0			
Tcu	5.0	Clay; residual from basalt; gray.	2.0- 9.0	5.4	5.7	13.7
	6.0	Clay; residual from basalt; blue.	9.0-14.0	4.9	5.0	12.4
Tlu	9.0	Clay, transported, tan and brown, sandy.	14.0-20.0			
	14.0	Sand, transported, tan and gray, clayey; some iron-stained gravel.				
	20.0	Clay, transported, gray, heavily iron-stained.				
Tcl?		Basalt.				
Drill hole M-58. Coordinates 27,840N, 24,940E						
Qp	2.0	Soil and Palouse formation.	0.0- 2.0			
Tcl	7.0	Clay; residual from basalt; gray-blue, iron-stained.	2.0- 7.0	9.0	17.4	21.6
			7.0-12-0	9.6	19.8	22.6
	12.0	Clay; residual from basalt; gray, limonite.	12.0-33.0			
	17.0	Clay; residual from basalt; gray, heavily iron stained.				
	22.0	Clay; residual from basalt; brown, iron-stained.				
Tll	27.0	Clay, transported, purplish-white and reddish-brown; sandy seams.				
KJg	33.0	Granite, semidecomposed.				
Drill hole M-59. Coordinates 27,970N, 24,540E						
Qp	2.0	Soil and Palouse formation.	0.0- 2.0			
Tcl	5.0	Basalt, decomposed, contains green nontronite.	2.0- 5.0	7.6	16.2	16.5
			5.0-10.5	7.1	16.9	17.6
	10.5	Clay, residual from basalt, green and bluish-green.				
		Basalt, decomposed.				
Drill hole M-60. Coordinates 27,475N, 24,610E						
Qp	3.0	Soil and Palouse formation.	0.0- 3.0			
Tcl	8.0	Clay; residual from basalt; gray and tan.	3.0- 8.0	10.7	7.4	28.8
	13.0	Clay; residual from basalt; tan, blue, and brown; contains white amygdules.	8.0-13.0	10.3	11.8	28.4
			13.0-18.0	9.7	18.4	23.4
	18.0	Clay; residual from basalt; tan, blue, and brown; contains white amygdules, heavily iron stained.	18.0-24.0	8.3	17.4	20.6
	24.0	Clay; residual from basalt; tan; tuffaceous; iron-stained.				
		Basalt, semidecomposed.				
Drill hole M-61. Coordinates 26,825N, 24,985E						
Qp	28.0	Soil and Palouse formation.	0.0-32.0			
Tlu	32.0	Gravel, transported.				
Drill hole M-62. Coordinates 26,790N, 25,570E						
Tlu	20.0	Sand, transported, white, yellow, gray; micaceous, clayey.	0.0-35.0			
	23.0	Clay, transported, gray.				
	35.0	Sand, transported, micaceous, slightly clayey.				

Drill hole logs and results of assays of the Excelsior deposit—Continued

Lithologic unit			Sample unit			
Formation symbols	Depth (feet)	Description	Length (feet)	Ignition loss (percent)	Available Fe_2O_3 (percent)	Available Al_2O_3 (percent)
Drill hole M-63. Coordinates 27,460N, 24,840E						
Qp	1.0	Soil and Palouse formation.	0.0- 1.0			
Tcl	6.0	Clay, tuffaceous, yellow; semidecomposed vesicular basalt ash fragments.	1.0- 6.0	6.9	11.0	17.6
	10.0	Tuff, semidecomposed, yellow.	6.0-10.0	6.2	13.2	14.0
		Basalt, decomposed.				
Drill hole M-64. Coordinates 27,735N, 23,800E						
Qp	5.0	Soil and Palouse formation.	0.0- 5.0			
	10.0	Palouse formation; mixed blue basalt clay and mica.	5.0-10.0	5.2	13.3	12.5
	12.0	Palouse formation; blue clay, residual from basalt; brown micaceous sand at bottom.	10.0-12.0	4.7	13.1	10.1
Drill hole M-65. Coordinates 24,810N, 25,655E						
Qp	12.0	Soil and Palouse formation.	0.0-17.0			
Tlu	14.0	Clay, transported, red.	17.0-22.0	10.0	4.0	28.7
Tcl	22.0	Clay; residual from basalt; blue.	22.0-27.0	10.7	6.5	29.6
	27.0	Clay; residual from basalt; blue; tan tuffaceous clay.	27.0-32.0	10.7	5.2	30.6
			32.0-37.0	10.4	11.5	26.9
	32.0	Clay; residual from basalt; blue; amygduloidal.	37.0-41.0	8.4	7.4	23.7
	37.0	Clay; residual from basalt; blue; iron-stained.				
	41.0	Clay; residual from basalt; blue.				
		Basalt, semidecomposed, blue.				
Drill hole M-66. Coordinates 26,340N, 23,820E						
Qp	6.0	Soil and glacial drift.	0.0- 6.0			
Drill hole M-67. Coordinates 22,425N, 23,810E						
Qp	7.0	Soil and Palouse formation.	0.0- 7.0			
Tcl	12.0	Clay, residual from basalt; tan and gray; iron-stained.	7.0-12.0	5.0	16.7	20.0
			12.0-17.0	9.0	14.2	21.6
	17.0	Clay; residual from basalt; brownish gray; iron-stained, amygduloidal.	17.0-21.0	8.5	15.8	19.5
	21.0	Clay; residual from basalt; gray.				
		Basalt, semidecomposed brownish-gray.				
Drill hole M-68. Coordinates 23,405N, 24,320E						
Qp	20.0	Soil and Palouse formation.	0.0-20.0			
Drill hole M-69. Coordinates 22,030N, 23,810E						
Qp	12.0	Soil and Palouse formation.	0.0-14.0			
Tcl	14.0	Clay; residual from basalt; gray-green, amygduloidal, iron-stained.				
		Basalt, semidecomposed.				

Drill hole logs and results of assays of the Excelsior deposit—Continued

Lithologic unit			Sample unit			
Formation symbols	Depth (feet)	Description	Length (feet)	Ignition loss (percent)	Available Fe_2O_3 (percent)	Available Al_2O_3 (percent)
Drill hole M-70. Coordinates 22,375N, 23,295E						
Qp	2.5	Soil and Palouse formation.	0.0–2.5			
Tcl	6.0	Clay; residual from basalt, green-gray.	2.5–6.0	6.9	14.8	15.5
		Basalt, semidecomposed.				
Drill hole M-71. Coordinates 21,855N, 23,250E						
Qp	3.0	Soil and Palouse formation.	0.0–3.0			
Tcl	8.5	Clay; residual from basalt; gray-green.	3.0–8.5	6.3	15.3	14.5
		Basalt, semidecomposed.				
Drill hole M-72. Coordinates 22,375N, 22,800E						
Qp	1.0	Soil and Palouse formation.	0.0–1.0			
Tcl	6.0	Clay; residual from basalt; brown and dark gray; iron-stained.	1.0–6.0	9.5	19.3	20.5
	9.0	Clay; residual from basalt; dark blue and brown; hard at base.	6.0–9.0	8.4	15.9	19.4
		Basalt, semidecomposed, green.				
Drill hole M-73. Coordinates 24,735N, 24,315E						
Qp	18.0	Soil and Palouse formation.	0.0–18.0			
	23.0	Clay; residual from basalt; blue; iron-stained; water at 20 ft.	18.0–23.0	8.2	6.6	23.5
		Basalt.				
Drill hole M-74. Coordinates, 25,285N, 24,305E						
Qp	10.0	Soil and Palouse formation.	0.0–13.0			
Tlu	11.5	Clay, transported, heavily iron-stained.	13.0–18.0	11.2	7.4	29.4
	13.0	Sand and clay, transported, white.	18.0–23.0	9.2	5.4	27.6
Tcl	18.0	Clay; residual from basalt; blue; iron-stained.	23.0–25.0	6.8	3.4	15.7
	23.0	Do.				
	25.0	Do.				
		Basalt, semidecomposed.				
Drill hole M-75. Coordinates, 25,885N, 24,245E						
Qp	15.0	Soil and Palouse formation.	0.0–17.0			
Tlu	17.0	Bog iron.	17.0–22.0	10.7	3.7	30.4
Tcl	22.0	Clay; residual from basalt; blue.	22.0–27.0	11.1	2.0	32.8
	27.0	Clay; residual from basalt; gray.	27.0–32.0	11.1	1.9	33.2
	32.0	Do.	32.0–38.0	10.9	5.2	31.4
	38.0	Clay; residual from basalt; light-gray; iron-stained.	38.0–40.0	8.8	5.0	23.6
	40.0	Clay; residual from basalt; brown and white; iron-stained.	40.0–45.0	10.5	4.0	32.1
	45.0	Clay; residual from basalt; gray; iron-stained.	45.0–49.0	9.8	10.4	26.4
	49.0	Do.				
		Basalt, semidecomposed.				
Drill hole M-76. Coordinates, 26,890N, 22,880E						
Qp	12.0	Soil and Palouse formation.	0.0–17.0			
	17.0	Palouse formation.				
		Gravel.				

Drill hole logs and results of assays of the Excelsior deposit—Continued

Lithologic unit			Sample unit			
Formation symbols	Depth (feet)	Description	Length (feet)	Ignition loss (percent)	Available Fe_2O_3 (percent)	Available Al_2O_3 (percent)
Drill hole M-77. Coordinates, 26,390N, 22,720E						
Qp	1.0	Soil and Palouse formation.	0.0–5.0			
	5.0	Sand and gravel.	5.0–10.0	8.1	10.0	20.8
Tcl	10.0	Clay; residual from basalt; blue; and yellow tuffaceous clay.	10.0–15.0	8.2	9.9	22.7
	15.0	Do.	15.0–18.0	8.0	9.1	23.1
	18.0	Clay; residual from basalt; blue.				
Drill hole M-78. Coordinates, 22,980N, 14,460E						
Qp	18.0	Soil and Palouse formation.	0.0–24.0			
Tlu	21.0	Sand, transported.	24.0–29.0	10.9	2.4	30.2
	23.0	Clay, transported, white, iron-stained.	29.0–34.0	11.1	1.8	31.5
	24.0	Clay, transported, white, heavily iron-stained	34.0–42.0	10.6	2.2	29.9
Tcl	29.0	Clay; residual from basalt; blue.				
	34.0	Do.				
	42.0	Do.				
Drill hole M-79. Coordinates, 24,075N, 14,955E						
Qp	7.0	Soil and Palouse formation.	0.0–13.0			
	13.0	Palouse formation and gravel.	13.0–19.0	5.4	3.5	16.7
Tcl	19.0	Clay; residual from basalt; blue.	19.0–20.0			
	20.0	Basalt, semidecomposed, brown				
Drill hole M-80. Coordinates, 23,475N, 15,500E						
Qp	12.0	Soil and Palouse formation.	0.0–12.0			
Tcl	15.0	Clay; residual from basalt; green-gray.	12.0–15.0	10.6	2.7	29.9
	17.0	Clay; residual from basalt; blue.	15.0–17.0			
	22.0	Do.	17.0–22.0	10.8	2.6	31.8
	31.0	Do.	22.0–31.0	10.1	2.2	30.2
Drill hole M-81. Coordinates, 22,490N, 15,155E						
Qp	5.0	Soil and Palouse formation.	0.0–9.0			
Tlu	9.0	Sand, transported, micaceous.	9.0–15.0	11.0	2.4	31.2
Tcl	15.0	Clay; residual from basalt; blue.	15.0–17.0	5.0	11.6	11.6
	17.0	Clay; residual from basalt; gray; some semidecomposed basalt.				
		Basalt.				
Drill hole M-82. Coordinates, 22,020N, 14,080E						
Qp	10.0	Soil and Palouse formation.	0.0–10.0			
Tcl	16.0	Clay; residual from basalt; blue, iron-stained.	10.0–16.0	10.6	11.2	26.1
			16.0–21.0	10.8	8.6	28.4
	21.0	Clay; residual from basalt; blue.	21.0–26.0	10.6	8.6	27.1
	26.0	Do.	26.0–32.0	9.4	12.6	24.4
	32.0	Clay; residual from basalt; gray and brown; hard.				
		Clay; residual from basalt; brown; hard; yellow tuffaceous clay.				

Drill hole logs and results of assays of the Excelsior deposit—Continued

Lithologic unit			Sample unit			
Formation symbols	Depth (feet)	Description	Length (feet)	Ignition loss (percent)	Available Fe_2O_3 (percent)	Available Al_2O_3 (percent)
Drill hole M-83. Coordinates, 21,605N, 13,860E						
Qp	14.0	Soil and Palouse formation.	0.0–17.0			
	17.0	Palouse formation and gravel.	17.0–22.0	9.8	8.1	25.1
Tcl	22.0	Clay; residual from basalt; speckled gray and blue.	22.0–25.0	10.1	9.9	26.7
	25.0	Do.	25.0 28.0	9.6	8.5	25.0
	28.0	Clay; residual from basalt; brown and blue.				
		Basalt, semidecomposed.				
Drill hole M-84. Coordinates, 22,630N, 16, 295E						
Qp	2.0	Soil and Palouse formation.	0.0–16.0			
	6.0	Gravel.	16.0–21.0	9.2	9.4	23.7
	12.0	Palouse formation and gravel.	21.0–25.5	9.7	0.7	28.3
Tlu	16.0	Sand and clay, transported, white.				
Tcl	21.0	Clay; residual from basalt; blue.				
	25.5	Do.				
Drill hole M-85. Coordinates						
Qp	10.0	Soil and Palouse formation.	0.0–10.0			
Tcl	15.0	Clay; residual from basalt; blue.	10.0–15.0	10.7	2.6	32.4
	20.0	Do.	15.0–20.0	9.7	13.8	24.4
	23.0	Do.	20.0–23.0	6.4	15.4	21.9
		Basalt.				

Drill hole logs and assay data of the Bovill deposit

Formation	Depth (feet)	Description	Ignition loss	Availability Fe_2O_3	Availability Al_2O_3
Drill hole B-1. Coordinates, 17,230N, 16,830E. Elevation, 3,045 feet					
Qp	3.8	Soil and Palouse formation			
Tl	9.2	Clay, transported, yellow-brown	10.3	3.7	28.0
	10.5	Clay, transported, brown, sandy	5.0	7.8	12.2
	13.2	Clay, transported, gray; brown bands	10.3	2.2	29.6
	18.2	Clay, transported, gray and yellow	8.0	2.2	22.9
	22.0	Clay, transported, yellow-brown			
	24.5	Clay, transported, red-brown, sandy	2.6	1.9	7.9
	25.3	Limonite, hard	8.2	19.5	18.2
	29.5	Clay, transported, yellow, plastic	10.3	7.2	27.5
	35.5	Clay, transported, gray, plastic	10.6	1.9	30.2
	45.5	Clay, transported, gray, sandy	3.7	1.7	10.1
	50.5	do	7.4	1.2	20.4
	52.1	Clay, transported, gray, plastic			
	53.3	Clay, transported, gray			
	55.9	Clay, transported, yellow	7.8	2.7	22.1
	60.9	Clay, transported, yellow, very sandy	2.7	1.9	8.1
	63.0	Sand and gravel, transported			

Drill hole logs and assay data of the Bovill deposit—Continued

Formation	Depth (feet)	Description	Ignition loss	Availability Fe_2O_3	Availability Al_2O_3
		Drill hole B–2. Coordinates, 18,485N, 19,619E. Elevation, 3,023 feet			
Qp	3.8	Soil and Palouse formation			
Tl	8.2	Clay, transported, pink, sandy	5.9	6.5	14.9
	11.6	Clay, transported, yellow, plastic	10.5	4.1	29.1
	21.6	Clay, transported, white, sandy, micaceous	3.6	1.2	10.0
	29.6	Clay, transported, white; yellow sandy clay streaks	5.2	1.0	14.5
	32.6	Clay, transported, gray; streaks of pink and yellow plastic clay.	9.6	3.4	27.0
	36.4	Clay, transported, red, sandy; pink plastic streaks	2.8	3.1	8.1
	44.0	Clay, transported, gray, sandy	1.7	1.5	5.9
		Gravel, transported, pebble size	1.7	1.5	
		Drill hole B–3. Coordinates, 19,105N, 18,950E. Elevation, 3,051 feet			
Qp	5.3	Soil and Palouse formation			
Tl	9.3	Clay, transported, pink-yellow, sandy	5.9	2.1	16.2
	10.2	Clay, transported, red, sandy	6.0	4.8	15.2
	12.3	Clay, transported, yellow, sandy			
	21.0	Clay, transported, yellow, plastic	8.2	3.7	22.3
	22.5	Clay, transported, yellowish-white, sandy	3.6	1.3	10.1
	23.5	Clay, transported, yellowish-white, plastic			
	24.2	Clay, transported, yellowish-gray, plastic	6.7	2.4	19.2
	32.2	Clay, transported, yellow, sandy			
	33.0	Clay, transported, yellow; gray plastic streaks	5.0	1.9	14.1
	38.0	Clay, transported, yellow; sandy			
	38.7	Clay, transported, yellow, plastic; gray sandy streaks	1.7	1.9	4.7
	44.9	Clay, transported, pink, sandy	3.0	2.0	8.4
	46.9	Clay, transported, yellowish-white, plastic; streaks of pink sandy clay.	7.1	2.9	20.3
	51.0	Clay, transported, yellow and gray, plastic			
	52.8	Clay, transported, gray and pink, plastic			
	58.3	Clay, transported, yellow, sandy	3.4	1.5	9.5
		Drill hole B–4. Coordinates, 18,090N, 16,355E. Elevation, 3,062 feet			
Qp	14.0	Soil and Palouse formation			
Tl	18.5	Sand, transported, brown			
	21.9	Clay, transported, tan and gray; small amount of quartz, sand, and muscovite.	10.8	4.1	29.2
	31.3	Clay, transported, tan and gray slightly silty	9.0	1.7	25.5
	32.8	Clay, transported, yellow and gray; small amount of fine-grained muscovite and silt.	9.3	7.0	25.0
	34.5	Sand, transported, quartz, yellow; clayey and muscovitic; thin streak of hard limonite.	4.4	6.3	11.0
	47.8	Clay, transported, gray and yellow, slightly sandy, plastic.	8.4	1.7	24.2
	49.2	Clay, transported, pink, gray, and yellow, sandy	5.0	2.4	13.8
	51.4	Clay transported, tannish-gray, silty	10.5	2.7	31.1
	56.4	Sand and clay, transported, yellow, muscovitic	3.0	2.9	7.9
	64.3	Sand, transported, yellow-gray, clayey, muscovitic	3.2	1.7	9.9
	66.9	Sand, transported, yellow-gray, clayey, muscovitic; contains thin limonite bands.	3.2	4.1	8.0
	71.9	Clay, transported, yellow, slightly sandy, plastic	7.4	4.1	20.3
	74.8	Clay, transported, pinkish-gray and gray, silty; small amount of plastic sand.	9.9	1.5	27.5
	78.5	Sand, transported, yellow and gray, clayey, muscovitic	3.4	1.8	8.6
		Drill hole B–5. Coordinates, 19,900N, 18,605E. Elevation, 3,070 feet			
Qp	4.6	Soil and Palouse formation			
Tl	14.0	Clay, transported, gray and yellow, sandy	9.9	2.8	26.7
	17.7	Clay, transported, red and gray, sandy, muscovitic	4.1	2.2	10.3
	24.6	Clay, transported, yellow and gray, silty, plastic; some reddish sandy clay.	9.8	2.9	25.8
	27.5	Clay, transported, tannish-gray, slightly sandy, plastic.	10.5	1.5	28.9
	30.3	Clay, transported, yellow, gray, and pink; slightly sandy.	6.8	2.7	18.6
	33.8	Clay, transported, yellow and pink, sandy, muscovitic, plastic.	8.8	2.5	23.7

Drill hole logs and assay data of the Bovill deposit—Continued

Formation	Depth (feet)	Description	Ignition loss	Availability Fe_2O_3	Availability Al_2O_3
		Drill hole B–5—Continued			
Tl	41.4	Clay, transported, gray, yellow, and pink; sandy, plastic.	8.4	1.7	23.6
	49.8	Clay, transported, tannish-gray, sandy, muscovitic	4.2	1.1	11.5
	53.6	Clay, transported, gray and yellow, silty, plastic	9.9	3.8	26.8
	67.1	Sand, transported, tan-gray, clayey, muscovitic	3.6	2.0	10.5
	79.4	Clay, transported, gray, sandy, plastic	8.6	2.1	24.3
KJg	82.9	Clay, gray and brown, sandy; residual from granodiorite.	6.0	1.9	16.5
		Granodiorite			
		Drill hole B–6. Coordinates, 17,845N, 15,575E. Elevation, 3,038 feet			
Qp	9.2	Soil and Palouse formation			
Tl	19.2	Clay, transported, yellow-brown, sandy	3.7	2.9	9.7
	19.9	Clay, transported, yellow-brown, limonitic			
	22.9	Clay, transported, yellow, plastic	10.5	2.9	29.3
	25.7	Clay, transported, pink-gray, plastic			
	30.7	Clay, transported, light-gray and brown, sandy	3.0	2.0	8.2
	33.5	Clay, transported, gray, sandy	3.4	1.3	9.4
	38.5	Clay, transported, gray, sandy	3.8	3.2	9.5
	43.5	Clay, transported, gray and yellow-brown, sandy			
	44.5	Clay, transported, yellow; thin limonite bands			
	48.3	Clay, transported, gray	7.6	1.7	21.2
	53.5	Sand, transported, gray; coarse grained toward bottom	3.0	1.6	8.4
		Gravel, transported, pebble size			
		Drill hole B–7. Coordinates, 15,210N, 16,805E. Elevation, 3,042 feet			
Qp	4.5	Soil and Palouse formation			
Tl	7.0	Clay, transported, yellow, sandy; thin bands of hard limonite.	7.8	10.2	18.6
	14.5	Clay, transported; pink, gray, and yellow; sandy, plastic.	8.6	3.4	23.8
	19.5	Clay, transported, gray, sandy, plastic, tenacious	9.0	1.3	26.9
	25.8	Clay, transported, yellow and gray, sandy, muscovite	8.2	6.8	21.3
	37.4	Sandy, transported, quartz, yellow and brown, coarse-grained muscovitic; thin bands of hard brown limonite.	2.2	2.5	6.2
	40.9	Sand and gravel, transported, quartz, yellow, muscovitic.	1.7	1.7	4.3
	54.5	Clay, transported, yellowish-gray, muscovitic, sandy	4.2	1.7	11.2
	57.0	Clay, transported, gray; contains fine-grained muscovite and quartz, plastic.	8.4	2.7	23.0
	58.9	Sand, transported, quartz, yellow, muscovitic; thin limonite bands.	4.4	4.1	10.4
	60.3	Clay, transported, plastic, tan-gray and yellow; a little fine-grained quartz.			
Tcl	68.2	Clay, tannish white, palagonitic; residual from basalt, contains a few small vesicles filled with white kaolinite.	10.4	2.2	28.0
		Basalt; partly decomposed; thin cracks filled with green nontronite.			
		Drill hole B–8. Coordinates, 16,870N, 17,530E. Elevation, 3,028 feet			
Qp	5.1	Soil and Palouse formation			
Tl	6.5	Clay, transported, gray, sandy	10.6	2.0	29.1
	11.5	Clay, transported, yellow; gray sandy clay streaks	7.0	4.4	18.2
	16.5	——do	4.4	2.4	11.8
	21.5	——do	1.8	2.5	4.8
	23.0	Clay, transported, red, sandy			
	23.3	Limonite			
	24.9	Clay, transported, gray, plastic	8.2	6.3	21.7
Tcl	31.8	Clay; residual from basalt; yellow	8.4	11.5	22.1
	32.7	Clay; residual from basalt; blue	7.5	9.3	19.9
		Basalt			

Drill hole logs and assay data of the Bovill deposit—Continued

Formation	Depth (feet)	Description	Ignition loss	Availability Fe_2O_3	Availability Al_2O_3
Drill hole B–9. Coordinates, 19,830N, 21,360E. Elevation, 2,937 feet					
Qp	16.7	Soil and Palouse formation; contains pebble-sized quartz gravel.			
Tl	23.9	Clay, transported, yellow; white sandy clay streaks	4.5	4.4	13.4
	26.5	Clay, transported, yellow, plastic	9.6	11.6	25.8
	31.5	Clay, transported, pink-gray, plastic	10.5	3.2	30.4
Tcl	33.1	Clay, yellow-brown; residual from basalt	9.0	9.2	24.8
		Basalt			
Drill hole B–10. Coordinates, 15,930N, 14,290E. Elevation, 2,945 feet					
Qp	19.5	Soil and Palouse formation			
Tcl	24.5	Clay; residual from basalt; blue	7.3	8.3	19.9
	25.0	Basalt, partly decomposed			
		Basalt			
Drill hole B–11. Coordinates, 15,810N, 14,950E. Elevation, 3,024 feet					
Qp	7.5	Soil and Palouse formation; limonite at bottom			
Tl	12.5	Clay, transported, gray and yellow	9.5	2.8	26.1
	15.1	Clay, transported, gray and yellow, plastic			
	20.1	Clay, transported, white, sandy, micaceous	3.7	1.0	10.8
	23.5	Sand, transported, white, clayey			
Drill hole B–12 (HM 1). Coordinates, 10,015N, 10,080E. Elevation, 2,844 feet					
Qp	6.5	Soil and Palouse formation			
Tl	7.4	Clay, transported, yellow-gray	4.5	2.6	11.5
	11.5	Clay, transported, gray and yellow, plastic	7.1	2.5	19.7
	13.5	Clay, transported, yellow-brown, sandy; few quartz pebbles; thin limonite bands.	4.5	4.5	11.0
	17.0	Clay, transported, gray and brown, sandy	4.8	2.8	12.2
	18.5	Clay, transported, gray-pink and yellow, plastic			
	21.7	Clay, transported, red and yellow, plastic	10.9	18.1	25.5
	36.5	Clay, transported, gray, sandy, micaceous; water at 24.0 feet.	5.1	0.9	14.2
	41.5	Clay; transported, gray, brown, and yellow; plastic	10.0	3.7	27.3
KJg	46.5	Clay; residual from granodiorite; gray and yellowish brown.	7.2	3.7	19.4
	49.5	Clay; residual from granodiorite; brownish yellow, sandy.			
	52.4	Clay; residual from granodiorite; gray, sandy			
		Granodiorite			
Drill hole Morton 1. Location, NE¼NE¼ sec. 21, T. 40 N., R. 1 W., Boise Meridian					
Qp	9.5	Soil and Palouse formation			
Tl	12.5	Clay, transported, brown, sandy. Drilling stopped because of water.	1.3	1.7	3.7
Drill hole Helmer 1. Location, NE¼NW¼ sec. 21, T. 40 N., R. 1 W., Boise Meridian					
Qp	5.9	Soil and Palouse formation			
Tl	6.7	Clay, transported, gray, sandy, micaceous	2.9	2.3	7.8
	8.6	Clay, transported, red, sandy			
	8.8	Limonite			
	18.5	Clay, transported, gray and red			
		Sand, transported. Drilling stopped because of caving			

Drill hole logs and assay data of the Deary deposit

Formation	Depth (feet)	Description	Ignition loss	Availability Fe_2O_3	Availability Al_2O_3
Drill hole D–1. Coordinates, 6,735N, 26,705E. Elevation, 2,905 feet					
Qp	1.0	Soil and Palouse formation			
Tl	3.5	Limonite			
	9.0	Clay, transported, yellow, plastic	11.8	4.1	29.9
	12.5	Clay, transported, yellow and pink, plastic	11.9	2.2	32.3
Tcl	17.5	Clay; residual from basalt; yellow, blue, and red	11.9	8.6	23.1
	27.5	Clay; residual from basalt; yellow and light brown	11.1	21.3	24.6
	37.5	Clay; residual from basalt; light brown	10.5	23.2	22.9
	42.5	Clay; residual from basalt; blue-green; yellow streaks	10.0	14.4	22.7
		Basalt			
Drill hole D–2. Coordinates, 6,435N, 26,600E. Elevation, 2,920 feet					
Qp	9.5	Soil and Palouse formation			
Tl	14.5	Clay, transported, red and tan, fine-grained; scattered quartz grains.	11.7	10.9	30.3
	16.8	do	12.1	9.9	31.3
	26.8	Clay, transported, gray; streaked red and yellow; contains quartz silt, plastic.	11.9	3.5	31.8
	29.5	Clay, transported, plastic, pink and pinkish-white; fine quartz and muscovite.	10.8	2.2	29.2
	33.0	Clay, transported, yellow, sandy and muscovitic, streaked with gray, plastic clay.	8.6	2.4	22.5
	40.7	Clay, transported, gray, plastic; last 3 ft. has thin beds of fine quartz sand and muscovite, some pink clay.	11.0	3.0	29.8
	43.7	Clay, transported, plastic, white-gray; contains fine quartz silt and muscovite.	10.7	2.1	29.0
	50.0	Sand, transported, tan-gray, quartz, muscovitic, and clayey.	3.7	1.3	9.1
	58.0	Clay-sand, transported, gray, muscovitic	4.5	1.3	12.9
Tcl	59.8	Clay; redidual from basalt; blue, plastic [1]	9.7	3.6	25.1
	69.8	Clay; residual from basalt; blue; speckled by white; contains kaolinite amygdules. [1]	10.8	4.8	30.2
	74.8	Clay; residual from basalt; blue-gray, brown, and yellow-brown; incompletely decomposed; speckled by blue ilmenite flakes and white kaolinite amygdules.[1]	9.7	11.1	25.8
	84.8	Clay, residual from basalt, brown and yellow-brown, semidecomposed; speckled by blue ilmenite flakes and white kaolinite amygdules.[2]	9.1	15.5	21.7
	92.1	Clay, residual from basalt, yellow-brown, semi-decomposed; speckled by white, kaolinite amygdules and yellow-green, waxy nontrohite amygdules.[2]	9.1	14.8	21.0
		Basalt			
Drill hole D–3. Coordinates, 6,425N, 27,370E. Elevation, 2,885 feet					
Qp	8.5	Soil and Palouse formation			
Tl	13.0	Limonite			
Tcl	18.0	Clay; residual, basalt; blue	9.5	23.3	20.4
	23.0	Clay; residual from basalt; blue and yellow, thin limonite seams.	9.6	14.7	19.1
	28.0	Clay; residual from basalt; blue and yellow; thin limonite seams.	8.5	12.6	24.7
	32.7	Clay; residual from basalt; blue			
		Basalt			
Drill hole D–4. Coordinates, 7,360N, 28,430E. Elevation, 2,865 feet					
Qp	10.1	Soil and Palouse formation			
Tcl	15.1	Clay; residual from basalt; brown and blue; streaked yellow and white.	8.9	18.9	19.9
	20.1	Clay; residual from basalt; blue-gray			
	25.1	Clay; residual from basalt; yellow and blue	8.6	18.0	19.7
	29.0	do	7.6	18.3	17.7
		Basalt			

[1] Gallium content, 0.004 percent.
[2] Gallium content, 0.003 percent.

Drill hole logs and assay data of the Deary deposit—Continued

Formation	Depth (feet)	Description	Ignition loss	Availability Fe_2O_3	Availability Al_2O_3
Drill hole D–5. Location, SW¼SW¼ sec. 24, T. 40 N., R. 2 W. Elevation, 2,924 feet					
Qp	3.8	Soil and Palouse formation			
Tcl	8.0	Clay; residual from basalt; gray and blue	11.4	3.6	32.3
	13.0	Clay; residual from basalt; brown, blue, and yellow	11.4	8.7	31.7
	18.0	Clay; residual from basalt; brown	11.0	20.5	26.5
	29.5	do	10.9	20.5	24.5
		Basalt			
Drill hole D–6. Location, NW¼NW¼ sec. 24, T. 40 N., R. 2 W. Elevation, 2,924 feet					
Qp	8.8	Soil and Palouse formation			
Tc		Basalt			
Drill hole D–7. Location, NE¼NE¼ sec. 23, T. 40 N., R. 2 W. Elevation, 2,904 feet					
Qp	6.3	Soil and Palouse formation			
Tlu	11.3	Clay, transported, yellow, fine silt	10.9	15.1	26.3
	18.0	do	10.2	13.2	25.1
Tcl	19.1	Clay; residual from basalt; blue	11.6	7.2	31.0
	20.7	Clay; residual from basalt; gray, much limonite	9.4	13.4	23.3
	22.2	Clay; residual from basalt; blue	5.8	6.1	16.1
		Basalt			
Drill hole D–8. Location, NE¼SW¼ sec. 26, T. 40 N., R. 2 W. Elevation, 2,784 feet					
Qp	8.0	Soil and Palouse formation			
Tl	18.0	Clay, transported, pink; contains quartz and feldspar grains.	6.3	7.6	16.2
	22.5	Clay, transported, pink; contains quartz and feldspar grains.	5.3	5.4	13.8
	27.5	Clay, transported, pink, sandy, very micaceous			
	32.5	Clay, transported, pink and brown, sandy			
	43.9	do	5.8	7.0	15.7
	46.3	Clay, transported, pink, and yellow, plastic	9.2	4.3	25.2
	51.3	Clay, transported, yellow and gray	6.8	6.1	17.9
	56.1	Clay, transported, light-gray, plastic	6.8	3.7	18.7
	57.5	Clay, transported, yellow, plastic	6.8	3.1	18.1
	58.9	Clay, transported, light-gray, plastic			
	63.9	Clay, transported, yellow	9.4	16.7	21.6
	73.9	Clay, transported, yellow, sandy; last 5 ft stained pink	5.2	8.7	13.6
	83.9	Clay, transported, yellow, very sandy	5.1	6.2	13.5
	84.1				
Drill hole D–9. Coordinates, 5,730 N., 29,140 E. Elevation, 2,895 feet					
Qp	16.3	Soil and Palouse formation			
Tlu	23.0	Clay, transported, yellow; streaks of gray and pink plastic clay.	11.1	8.4	30.4
	33.0	Clay, transported, gray, plastic; pink and yellow streaks.	10.0	4.5	28.6
	38.0	Clay, transported, yellow; streaks of gray plastic clay	10.0	4.5	27.8
	40.9	Clay, transported, yellow, slightly sandy			
	44.8	Clay, transported, gray and pink, plastic	11.4	3.4	32.4
	45.4	Clay, transported, gray, sandy	9.1	2.2	25.0
	47.0	Clay, transported, pink, plastic			
	50.0	Clay, transported, gray and yellow, sandy, micaceous	6.0	1.4	17.2
	62.0	Clay, transported, light-gray, plastic; last 2 ft blue gray.	10.6	2.1	30.1
Tcl	69.5	Clay, blue; residual from basalt, yellow streaks	10.1	16.2	24.8
		Basalt			
Drill hole D–10. Coordinates, 6,365 N., 27,760 E., Elevation, 2,940 feet					
Qp	15.5	Soil and Palouse formation			
Tcu	16.3	Basalt, blue, semidecomposed			
		Basalt			

Drill hole logs and assay data of the Deary deposit—Continued

Formation	Depth (feet)	Description	Ignition loss	Availability Fe_2O_3	Availability Al_2O_3
Drill hole D–11. Coordinates, 6,420 N., 29,375 E. Elevation, 2,885 feet					
Qp	10.2	Soil and Palouse formation			
Tlu	18.0	Clay, transporttd, yellow; streaks of gray plastic clay	10.2	6.4	27.3
	19.6	Clay, transported, yellow, sandy; streaks of gray plastic clay.	9.3	4.4	25.3
	24.2	Clay, transported, gray and yellow, plastic	10.6	3.9	29.2
	26.5	Clay, transported, yellow, sandy, micaceous	8.5	2.8	22.8
	31.8	Clay, transported, gray, plastic; bottom 8 in. sandy	9.9	2.8	27.2
	39.9	Clay, transported, gray, plastic; top 3 ft pink and gray	9.7	1.7	26.6
	47.5	Sand and mica, transported, white, very little clay	3.4	1.5	8.8
Tcl	53.6	Clay, blue; residual from basalt, yellow streaks	10.0	3.1	28.7
	58.5	Clay, blue; residual from basalt; white, kaolinite amygdules	11.1	2.8	32.4
	63.2	Clay, blue; residual from basalt			
		Basalt			
Drill hole D–12. Coordinates, 6,365 N., 25,900 E. Elevation, 2,870 feet					
Qp	8.0	Soil and Palouse formation			
Tcl	16.7	Clay, brown and blue; residual from basalt	10.5	20.8	23.4
		Basalt			
Drill hole D–13. Coordinates, 6,730 N., 25,910 E. Elevation, 2,835 feet					
Qp	12.2	Soil and Palouse formation			
Tc		Basalt			
Drill hole D–14. Coordinates, 4,080 N., 31,030 E. Elevation, 2,745 feet					
Qp	18.5	Soil and Palouse formation			
Tlu	22.5	Sand, transported, coarse-grained			
	27.3	Clay, transported, blue and brown	4.9	8.0	12.3
	28.8	Gravel, transported, coarse-grained; water-bearing			
Tcl	29.0	Clay; residual from basalt; blue			
		Basalt			
Drill hole D–15. Coordinates, 5,440 N. 30,470 E. Elevation, 2,830 feet					
Qp	5.5	Soil and Palouse formation			
Tlu	15.5	Sand, transported, yellow			
	17.0	Sand, transported, yellow, clayey	3.1	1.4	7.9
	24.5	Clay, transported, gray and yellow, plastic	8.6	2.2	23.9
	25.3	Clay, transported, yellow, sandy	8.7	5.2	22.6
	28.0	Clay, transported, dark-gray, plastic			
Tcl	38.0	Clay, residual from basalt; blue; lower 5 ft yellow and blue.	10.4	7.0	27.8
	44.8	Clay, residual from basalt; brown and green; lower 1.8 ft green.	8.6	16.5	19.5
		Basalt			
Drill hole D–16. Coordinates, 3,790 N., 29,380 E. Elevation, 2,915 feet					
Qp	3.5	Soil and Palouse formation			
Tcl	26.0	Clay, brown, crumbly; residual from basalt; ilmenite grains, spots of white kaolinite; thin limonite bands (assay from 11.0 to 30.4).	11.4	18.7	26.6
	30.4	Basalt, blue, partly weathered			
		Basalt			
Drill hole D–17. Coordinates, 755 N., 26,180 E.					
Qp	4.0	Soil and Palouse formation			
Tc		Basalt			

Drill hole logs and assay data of the Deary deposit—Continued

Formation	Depth (feet)	Description	Ignition loss	Availability Fe_2O_3	Availability Al_2O_3
Drill hole D–18. Coordinates, 5,205E, 28,900E. Elevation, 2,890 feet					
Qp	14.5	Soil and Palouse formation			
Tcu	20.8	Basalt, light-brown, semidecomposed; ilmenite and feldspar grains discernible.			
Tlu	26.0	Clay, transported, red and tan; contains scattered quartz grains.	11.0	10.1	30.5
	31.0	Clay, transported, gray and red, plastic; contains silt and scattered sand grains of quartz.	11.2	9.1	31.4
	39.8	Clay, transported, gray, plastic; contains fine quartz silt and muscovite; upper 5 ft streaked red.	10.6	9.4	29.6
	43.2	Clay, transported, white-gray; contains thin yellow streaks; mixed with fine sand and muscovite.	8.2	2.9	22.9
	47.5	Sand, transported, muscovitic, clayey; thin band of limonite.	3.4	2.4	9.2
	49.2	Sand, transported, muscovitic; interbedded with limonite bands.	2.2	6.5	5.5
	50.3	Clay, transported, sandy, pink and gray			
	53.5	Clay, transported, gray, stained green, plastic			
	55.0	Clay, transported, gray, sandy	6.9	4.4	19.6
	57.8	Clay, transported, gray and white, plastic			
	66.8	Clay, transported, light-gray, sandy, muscovitic	5.4	1.7	15.9
	69.2	Sand, transported, gray and yellow, muscovitic and clayey.	4.6	1.9	12.6
	71.0	Clay, transported, gray and yellow			
	73.0	Clay, transported, light-bluish-gray, plastic, very fine silt.	10.9	3.8	30.0
Tcl	78.0	Clay, blue-gray; residual from basalt; speckled by blue ilmenite flakes and white kaolinite; stained yellow.[3]	9.8	14.4	25.5
	83.3	Clay, gray and yellow-brown, incompletely decomposed; residual from basalt; pale-green nontronite filling a few openings.[4]	8.6	16.3	21.3
Drill hole D–19. Coordinates, 1,000N, 26,910E					
Qp	12.0	Soil and Palouse formation			
Tcl	21.5	Clay, blue; residual from basalt	8.1	16.0	19.7
		Basalt			
Drill hole D–20. Coordinates, 3,790N, 29,030E. Elevation, 2,885 feet					
Qp	5.2	Soil and Palouse formation			
Tcl		Basalt			
Drill hole D–21. Coordinates, 3,815N, 28,970E. Elevation, 2,870 feet					
Qp	3.5	Soil and Palouse formation			
Tcl		Basalt			
Drill hole D–22. Coordinates, 3,815N, 28,920E. Elevation, 2,850 feet					
Qp	8.0	Soil and Palouse formation			
Tcl	14.2	Clay, blue; residual from basalt			
		Basalt			
Drill hole D–23. Coordinates, 3,855N, 28,780E. Elevation, 2,820 feet					
Qp	20.2	Soil and Palouse formation			
Tcl		Basalt			

[3] Gallium content, 0.004 percent.
[4] Gallium content, 0.003 percent.

Drill hole logs and assay data of the Deary deposit—Continued

Formation	Depth (feet)	Description	Ignition loss	Availability Fe_2O_3	Availability Al_2O_3
Drill hole D–24. Coordinates, 3,960N, 27,420E. Elevation, 2,875 feet					
Qp	10.2	Soil and Palouse formation			
Tcl	11.3	Clay, blue; residual from basalt			
		Basalt			
Drill hole H–1. Location, NW¼NW¼ sec. 19, T. 40 N., R. 1 W.					
Qp	2.0	Soil and Palouse formation			
Tlu	4.6	Sand, transported, brown, clayey	4.0	5.2	9.0
Tcl		Basalt, blue			
Drill hole H–2. Location, NE¼NW¼ sec. 19, T. 40 N., R. 1 W.					
Qp	23.8	Soil and Palouse formation			
Tlu	27.4	Sand, transported, brown, clayey; water-bearing and could not be penetrated.	2.8	4.2	6.5

Drill hole logs and assay data of the Olson deposit

Drill hole Ol–1. Coordinates, 12,000N, 14,995E. Elevation, 2,834 feet

Qp	12.0	Soil and Palouse formation			
Tlu	14.5	Clay, transported, sandy, iron-stained		3.0	29.6
	17.5	Clay, transported, sandy; less iron-stained than overlying unit.		4.7	25.4
	18.0	Clay, transported, gray, slightly sandy		1.5	29.6
	21.3	Clay, transported, pink-brown, sandy, micaceous		1.5	8.8
	23.0	Sand, transported, yellow-brown; small amount of iron-stained clay.		4.6	29.8
	26.5	Clay, transported, gray-white; becomes darker near 25 ft.		1.3	32.6
	33.5	Clay, transported, white, sandy, iron-stained; bottom 18 in. has 1-in. bands of hard limonite.		0.9	13.7
	35.0	Clay, transported, yellow-brown		4.1	16.7
	43.0	Clay, transported, pink and dark red; 5 in. of white clay at 37 ft.		2.0	27.5
	48.0	Clay, transported, pinkish-gray, plastic		1.8	23.8
	49.2	Clay, transported, pinkish-gray, plastic		1.9	19.9
Tcl	50.3	Clay, greenish-brown; residual from basalt; drilling stopped because of caving.		6.3	16.8
Drill hole Ol–2. Coordinates, 13,000N, 15,005E. Elevation, 2,870 feet					
Qp	10.2	Soil and Palouse formation			
	15.2	Palouse formation		0.9	11.9
	17.0	Palouse formation; bottom 12 in. micaceous		1.0	11.7
Tlu	18.5	Sand, transported, coarse-grained, micaceous; three limonite streaks at 4-in. intervals at bottom 12 in.			
	22.1	Clay, transported, sandy, iron-stained		1.5	12.1
	26.5	Clay, transported, yellow		2.0	26.6
	29.2	Clay, transported, gray		2.1	27.3
	31.5	Clay, transported, yellow, sandy		2.1	15.0
	32.7	Clay, transported, pink, sandy		2.1	28.3
	33.1	Clay, transported, pinkish-gray		1.6	19.0
	35.0	Clay, transported, reddish-orange, sandy		2.1	22.0
	39.0	Clay, transported, pink		2.4	21.5
	41.5	Sand, transported, orange, coarse, micaceous		3.5	27.5
	43.5	Clay, transported, gray, black-stained		3.6	27.3

Drill hole logs and assay data of the Olson deposit—Continued

Formation	Depth (feet)	Description	Ignition loss	Availability Fe_2O_3	Availability Al_2O_3
		Drill hole Ol-2.—Continued			
Tlu	47.0	Clay, transported, pinkish-gray, micaceous		2.1	24.3
	48.4	Clay, transported, yellowish-brown; dry		3.0	12.8
	50.8	Clay, transported, white, plastic		1.4	34.4
	55.8	Sand, transported, pink and white, micaceous		0.9	13.3
	56.2	Clay, transported, orange, sandy		1.7	12.8
	61.2	Sand, transported, white, pink, and yellow, micaceous			
	62.3	Sand, transported, top 6 in. had to be chopped		20.0	14.6
	67.3	Clay, transported, grayish-white, plastic		5.6	28.4
	70.0	Clay, transported, dark pinkish-gray, plastic		2.2	30.8
Tcl	76.2	Clay; residual from basalt; yellowish-green		10.3	19.0
		Basalt			
		Drill hole Ol-3. Coordinates, 11,395N, 15,000E. Elevation, 2,809 feet			
Qp	6.9	Soil and Palouse formation; occasional spots of limonite; last 6 in. medium-grained sand.			
Tlu	8.3	Clay, transported, gray; sandy, micaceous		2.7	12.1
	10.2	Clay, transported, yellow; fine-grained iron-stained sand.		1.3	13.1
	17.0	Clay, transported, gray; fine-grained slightly micaceous sand; water at 12.1 ft.		1.7	11.5
	19.0	Clay, transported, red; medium-grained sand		2.0	9.8
Tcl	28.8	Clay, gray, plastic; residual from basalt, thin white streaks at intervals.		2.0	25.3
	31.5	Clay, yellowish brown; residual from basalt; bottom 1.7 ft decomposed basalt.		7.9	11.1
		Basalt			
		Drill hole Ol-4. Coordinates, 13,990N, 15,000E. Elevation, 2,808 feet			
Qp	1.4	Soil and Palouse formation; occasional spots of limonite			
	2.8	Palouse formation, buff-colored, tuffaceous		3.4	6.0
Tlu	6.7	Sand, transported hard; bottom 6 in. cemented by limonite.			
Tcl	9.0	Clay, residual from basalt, partly decomposed; some dark-green nontronite.		9.9	17.3
	9.5	Basalt			
		Drill hole Ol-5. Coordinates, 12,000N, 14,040E. Elevation, 2,849 feet			
Qp	20.5	Soil and Palouse formation, slightly sandy			
Tlu	21.7	Clay, transported, brown, sandy, iron-stained			
	22.5	Clay, transported, yellow		3.0	25.1
	29.5	Clay, transported, dark-yellow, sandy, micaceous; streaked with nonsandy blue clay.		4.6	27.3
	31.1	Clay, transported, yellow, sandy, micaceous		2.6	24.9
	33.5	Clay, transported, dark-yellow, sandy; some nonsandy, micaceous, blue clay.		4.9	24.3
	35.5	Clay, transported, red; coarse-grained sand		2.0	15.4
	38.6	Clay, transported, light-brown, plastic; top 2 in. pink clay.		7.9	28.7
	43.6	Clay, transported, pink to white, slightly sandy, plastic.		5.7	30.2
	48.0	Clay, transported, pink to white, slightly sandy, plastic; bottom 18 in. becomes more sandy.		1.9	32.3
	53.0	Clay, transported, pinkish-gray, plastic		1.5	31.8
Tcl	57.1	Clay; residual from basalt; greenish-gray		5.7	22.9
	59.4	Clay; resiRual from basalt; yellowish-gray		4.9	19.6
	60.9	Clay; residual from basalt; blue		4.3	21.1
		Basalt			
		Drill hole Ol-6. Coordinates, 13,990N, 14,035E. Elevation, 2,812 feet			
Qp	2.4	Soil and Palouse formation; some limonite			
	6.3	Palouse formation, buff-colored, tuffaceous, hard		4.4	5.8
Tlu	12.5	Sand, transported, very hard; bottom 3 ft cemented by limonite.			
Tcl	13.3	Basalt			

Drill hole logs and assay data of the Olson deposit—Continued

Formation	Depth (feet)	Description	Ignition loss	Availability Fe_2O_3	Availability Al_2O_3
		Drill hole Ol-7. Coordinates, 11,000N, 14,000E. Elevation, 2,818 feet			
Qp	15.0	Soil and Palouse formation; bottom 5 ft very hard			
Tlu	16.6	Clay, transported, brown, sandy, micaceous		7.7	10.8
	17.5	Clay, transported, brown		15.6	21.5
	30.0	Clay, transported, gray with occasional pinkish tint, plastic; 1-ft. beds of white powdery clay at 20 and 23 ft.		2.1	30.0
Tcl	33.4	Clay; residual from basalt; blue; plastic; hard		3.3	24.2
		Basalt			
		Drill hole Ol-08. Coordinates, 13,000N, 14,000E. Elevation, 2,832 feet			
Qp	14.5	Soil and Palouse formation; bottom 3 ft very hard			
Tlu	17.0	Clay, transported, orange, sandy, micaceous			
	21.0	Clay, transported, yellow, plastic, iron-stained		5.1	26.9
	21.5	Clay, transported, light-gray, sandy; water at 21.5 ft		3.0	20.0
	33.5	Clay, transported, yellow to dark-gray, plastic; bottom 6 in. greenish gray and sandy.		3.0	28.6
Tcl	35.5	Clay, black, gray-speckled; residual from basalt; incompletely decomposed.		8.0	23.2
	37.0	Basalt, with a little black clay; partly decomposed		5.0	15.0
		Basalt			
		Drill hole Ol-9. Coordinates, 12,000N, 13,030E. Elevation, 2,879 feet			
Qp	12.5	Soil and Palouse formation			
Tlu	14.8	Sand, transported, orange, very coarse			
	20.0	Sand, transported, brown, coarse; top 6 in. of gray clay			
	21.0	Sand, transported, pink, micaceous			
	26.3	Sand, transported, orange, coarse, micaceous			
	31.5	Clay, transported, pale-yellow		2.3	27.3
	37.0	Clay, transported, pale-yellow, sandy			
	38.5	Sand, transported, orange micaceous		1.4	12.9
	42.2	Clay, transported, pale-yellow, sandy			
	45.0	Clay, transported, pink, sandy, micaceous; top 6 in. red plastic clay.		1.6	16.7
	46.0	Sand, transported, pink, clayey		2.0	10.0
	49.8	Clay, transported, yellow, plastic, white-streaked		2.7	32.4
	50.8	Clay, transported, pink and yellow, very hard plastic		4.7	27.4
Tlu	52.5	Clay, transported, yellow		2.5	27.7
	57.5	Clay, transported, white, very sandy, micaceous		0.8	11.1
	59.5	Sand, transported, very coarse		3.6	14.5
	60.8	Clay, transported, yellow, plastic			
	61.4	Limonite, hard		40.0	10.0
	63.5	Clay, transported, yellow, plastic		12.7	25.7
	64.7	Clay, transported, pale-pink to gray			
	69.3	Clay, transported, black to brown, plastic		1.7	30.5
	71.5	Clay, transported, pinkish-brown to white, plastic		1.1	33.1
	72.7	Clay, yellow-gray; residual from basalt		2.2	30.0
	77.0	Clay, blue; residual from basalt		2.4	29.6
	77.7	Clay, yellow; residual from basalt; contains coarse grains of incompletely decomposed basalt.		4.8	21.5
	78.3	Clay, blue to yellow; residual from basalt; contains grains of incompletely decomposed basalt.			
		Basalt			
		Drill hole Ol-10. Coordinates, 10,990N, 12,995E. Elevation, 2,832 feet			
Qp	11.8	Soil and Palouse formation			
Tlu	14.9	Sand, transported, gray, slightly clayey		2.3	28.8
	24.8	Clay, transported, gray, very sandy		3.0	16.6
	29.6	Sand, transported, white, very micaceous			
	30.4	Limonite, hard		40.0	10.0
	37.4	Clay, transported, pinkish-gray		1.1	28.5
	42.0	----do		11.6	26.7
Tcl	43.5	Clay; residual from basalt; bluish gray, powdery		1.6	18.9
	44.7	Clay; residual from basalt; yellowish-gray		3.7	23.4
	45.5	Clay; residual from basalt; blue			
		Basalt			

Drill hole logs and assay data of the Olson deposit—Continued

Formation	Depth (feet)	Description	Ignition loss	Availability Fe_2O_3	Availability Al_2O_3
Drill hole Ol-11. Coordinates, 10,990N, 12,000E. Elevation, 2,829 feet					
Qp	9.9	Soil and Palouse formation			
Tlu	14.0	Clay, transported, gray, sandy			
	15.3	Clay, transported, red, hard; contains limonite		28.4	13.4
	16.2	Clay, transported, red		2.8	29.8
	23.5	Clay, transported, pinkish-gray, plastic; white powdery streaks.		3.6	30.8
Tcl	28.5	Clay, yellowish-brown; residual from basalt		7.8	19.0
	29.5	ditto		11.0	15.4
		Basalt			
Drill hole Ol-12. Coordinates, 12,000N, 12,030E. Elevation, 2,818 feet					
Qp	8.0	Soil and Palouse formation; bottom 2 ft very hard			
Tlu	20.0	Clay, transported, gray, plastic; bottom 4 ft yellowish gray.		3.9	26.8
Tcl	20.6	Basalt, partially decomposed		7.0	10.0
		Basalt			
Drill hole Ol-13. Coordinates, 12,010N, 11,035E. Elevation, 2,828 feet					
Qp	25.0	Soil and Palouse formation; bottom portion hard			
Tcl	30.6	Clay; residual from basalt; blue		5.1	26.1
		Basalt			
Drill hole Ol-14. Coordinates, 10,960N, 11,025E. Elevation, 2,832 feet					
Qp	15.0	Soil and Palouse formation			
Tc		Basalt			
Drill hole Ol-15. Coordinates, 10,965N, 10,065E. Elevation, 2,802 feet					
Qp	9.5	Soil and Palouse formation			
Tc		Basalt			
Drill hole Ol-16. Coordinates, 10,000N, 12,000E. Elevation, 2,855 feet					
Qp	12.5	Soil and Palouse formation			
Tlu	13.5	Clay, transported, gray			
	14.8	Clay, transported, yellow-gray		2.3	21.9
	16.5	Clay, transported, gray, sandy, micaceous			
	17.3	Clay, transported, brown, coarse-grained sand		8.3	22.4
	20.2	Clay, transported, light-brown, pink-streaked			
	31.3	Clay, transported, pinkish-gray, plastic; white powdery streaks.		2.0	32.6
Tcl	36.4	Clay, blue; residual from basalt		2.0	29.9
		Basalt			
Drill hole Ol-17. Coordinates, 12,990N, 13,030E. Elevation, 2,868 feet					
Qp	5.0	Soil and Palouse formation; bottom portion hard			
Tlu	11.5	Sand, transported, orange, hard			
	12.0	Sand, transported, yellow, clayey			
	12.5	Sand, transported, orange			
	15.0	Clay, transported, violet, pink, and white, plastic		2.2	28.1
	17.0	Clay, transported, yellow, dry		2.6	22.3
	24.0	Clay, transported, pink, sandy, micaceous		3.9	13.7
	26.0	Sand, transported, brown; contains pink clay			
	32.0	Clay, transported, yellow, dry		4.7	23.7
	33.5	Clay, transported, white, plastic		1.8	27.4
	35.0	Clay, transported, yellow, sandy		3.0	15.1
	41.0	Clay, transported, white, plastic		1.6	28.4
	45.0	Clay, transported, yellow, sandy		3.1	14.7
		Limonite, hard			

Drill hole logs and assay data of the Olson deposit—Continued

Formation	Depth (feet)	Description	Ignition loss	Available Fe_2O_3	Available Al_2O_3
Drill hole Ol-18. Coordinates, 10,000N, 13,000E. Elevation, 2,825 feet					
Qp	13.5	Soil and Palouse formation			
Tlu	14.0	Limonite, red, hard			
	17.8	Clay, transported, yellow, slightly sandy		12.5	28.1
	29.0	Clay, transported, pink to gray, micaceous; white powdery streaks.		1.9	32.6
Tcl	39.4	Clay; residual from basalt; greenish-brown			
		Basalt			
Drill hole Ol-19. Coordinates, 13,960N, 12,980E. Elevation, 2,828 feet					
Qp	11.0	Soil and Palouse formation; bottom 3 ft very hard			
Tlu	13.0	Clay, transported, pink, sandy, slightly micaceous			
	13.5	Limonite, hard			
	20.8	Clay, transported, dark-gray, plastic		2.0	31.8
	23.8	Clay, transported, orange to yellow		1.9	25.3
Tcl	24.7	Clay; residual from basalt		1.9	32.3
	30.8	Clay; residual from basalt; yellowish-brown, dry and powdery.		12.6	20.0
	32.0	Clay; residual from basalt; yellowish-brown, plastic, white-streaked.			
	34.6	Clay; residual from basalt; blue and yellow; contains some grains of incompletely decomposed basalt.		8.7	22.5
		Basalt			
Drill hole Ol-20. Coordinates, 13,950N, 12,100E. Elevation, 2,823 feet					
Qp	14.5	Soil and Palouse formation; bottom portion hard			
Tc		Basalt			
Drill hole Ol-21. Coordinates, 12,975N, 12,035E. Elevation, 2,842 feet					
Qp	27.8	Soil and Palouse formation			
Tcl	37.8	Clay, residual from basalt; greenish-yellow		14.1	18.5
	45.4	----Do		16.3	17.6
		Basalt			
Drill hole Ol-22. Coordinates, 10,000N, 14,000E. Elevation, 2,798 feet					
Qp	9.4	Soil and Palouse formation; bottom portion hard			
Tc		Basalt			
Drill hole Ol-23. Coordinates, 8,995N, 13,000E. Elevation, 2,875 feet					
Qp	28.0	Soil and Palouse formation			
Tlu	29.5	Clay, transported, yellow, sandy		3.0	21.0
	31.2	Clay, transported, yellowish-white		2.3	29.0
	35.5	Sand, transported, orange, micaceous		1.4	9.1
	37.5	Clay, transported, yellowish-white		3.3	30.3
	41.2	Clay, transported, pinkish-orange-white		2.5	28.2
	43.0	Sand, transported, orange		2.7	12.1
	44.7	Clay, transported, gray		2.7	23.9
	47.0	Clay, transported, yellowish-white		3.0	24.2
	47.5	Clay, transported, gray			
	49.0	Clay, transported, sandy, very hard		2.4	13.1
	50.5	Clay, transported, yellow-gray, plastic		14.2	28.7
	53.5	Clay, transported, light-brown			
	63.8	Clay, transported, pinkish-gray, plastic		2.2	33.2
Tcl	68.0	Clay; residual from basalt; yellowish blue		3.0	29.2
		Basalt			

Drill hole logs and assay data of the Olson deposit—Continued

Formation	Depth (feet)	Description	Ignition loss	Available Fe_2O_3	Available Al_2O_3
		Drill hole Ol-24. Coordinates, 13,945N, 11,050E. Elevation, 2,852 feet			
Qp	9.7	Soil and Palouse formation			
Tlu	12.2	Clay, transported, light-brown		6.3	30.7
	14.3	Clay, transported, gray, brown-streaked			
	18.5	Clay, transported, gray, plastic		2.2	33.8
Tcl	22.1	Clay; residual from basalt; reddish-brown		20.0	26.3
	23.5	Clay; residual from basalt; blue		6.6	31.5
	26.9	Clay; residual from basalt; various colors		12.8	28.4
	28.4	Clay; residual from basalt; blue		2.1	34.3
	29.5	Clay; residual from basalt; brown		22.1	23.8
		Basalt			
		Drill hole Ol-25. Coordinates, 8,000N, 13,010E. Elevation, 2,830.8 feet			
Qp	6.5	Soil and Palouse formation			
	8.5	Limonite			
Tlu	10.3	Clay, transported, orange, sandy		5.5	18.2
	11.0	Sand, transported, orange			
	13.8	Clay, transported, yellow, gray-streaked		3.9	34.3
	15.7	Sand, transported, brown, macaceous		4.5	12.8
	16.8	Sand, transported, yellow, macaceous			
	19.5	Clay, transported, yellow		4.2	30.2
	23.6	Sand, transported, brown, coarsely micaceous		4.2	11.6
	24.1	Limonite, clay-streaked		16.8	25.6
	26.5	Clay, transported, yellow			
	32.5	Clay, transported, pinkish-gray, plastic		1.8	33.2
Tcl	35.0	Clay; residual from basalt; yellowish-blue		1.4	33.7
	37.5	Clay; residual from basalt; yellow, brown, and blue; spotted red, blue, and yellow.		6.2	32.1
	39.5	Clay; residual from basalt; blue		1.4	33.5
	43.5	Clay; residual from basalt; yellow to brown		6.3	25.5
	44.5	Clay; residual from basalt; blue		3.6	29.5
		Basalt			
		Drill hole Ol-26. Coordinates, 13,965N, 10,045E. Elevation, 2,816 feet			
Qp	13.0	Soil and Palouse formation			
		Basalt			
		Drill hole Ol-27. Coordinates, 7,000N, 13,037E. Elevation, 2,835 feet			
Qp	11.8	Soil and Palouse formation; bottom portion hard			
Tlu	12.5	Clay, transported, white-yellow		1.3	14.8
	15.0	Clay, transported, pale-yellow, sandy			
	15.8	Sand, transported, brown, coarse-grained		2.6	23.2
	18.5	Clay, transported, pale-yellow, sandy		11.4	25.6
	21.0	Sand, transported; slight amount of yellow sandy clay			
	23.0	Clay, transported, yellow		4.0	7.3
	28.0	Sand, transported, micaceous, hard		2.6	6.3
	33.0	Sand, transported, yellow-white		9.4	16.8
	34.4	Clay, transported, brown, sandy			
	35.8	Clay, transported, orange			
	36.4	Limonite			
	39.7	Clay, transported, yellow		7.4	28.5
	44.1	Clay, transported, yellow-gray, blue-streaked			
	44.3	Limonite		40.0	10.0
	52.5	Clay, transported, pinkish-gray, white-streaked		2.1	32.3
Tcl	55.7	Clay, residual from basalt, gray		0.9	32.7
	60.7	do		1.2	32.0
	62.8	do		2.5	29.1
		Basalt			
		Drill hole Ol-28. Coordinates, 12,965N, 10,025E. Elevation, 2,815 feet			
Qp	14.5	Soil and Palouse formation			
Tc		Basalt			

Drill hole logs and assay data of the Olson deposit—Continued

Formation	Depth (feet)	Description	Ignition loss	Availability Fe_2O_3	Availability Al_2O_3
		Drill hole Ol-29. Coordinates 6,200N, 13,000E. Elevation 2,843 feet			
Qp	14.1	Soil and Palouse formation			
	15.0	Limonite			
Tlu	36.2	do			
Tcl	38.8	Basalt			
		Drill hole Ol-30. Coordinates, 12,850N, 11,045E. Elevation, 2,840 feet			
Qp	11.1	Soil and Palouse formation			
	12.6	Sand, Palouse formation, some limonite, micaceous			
Tlu	15.5	Clay, transported, reddish-gray		10.3	23.5
	18.2	Clay, transported, reddish-gray, slightly sandy			
	26.0	Clay, transported, pinkish-gray, white-streaked		3.3	30.1
Tcl	31.0	Clay; residual from basalt; blue		2.0	29.4
		Drill hole Ol-31. Coordinates, 6,200N, 12,000E. Elevation, 2,751 feet			
Qp	6.5	Soil and Palouse formation			
Tc	.5	Basalt			
		Drill hole Ol-32. Coordinates, 11,965N, 10,045E. Elevation, 2,797 feet			
Qp	12.2	Soil and Palouse formation			
Tc		Basalt			
		Drill hole Ol-33. Coordinates, 6,590N, 12,000E. Elevation, 2,783 feet			
Qp	10.3	Soil and Palouse formation; bottom portion hard			
Tc		Basalt			
		Drill hole Ol-34. Coordinates, 9,000N, 12,000E. Elevation, 2,858 feet			
Qp	3.0	Soil and Palouse formation			
Tlu	5.0	Clay, transported, light-yellow, sandy	3.8	4.9	7.7
	9.0	Clay, transported, yellow	10.3	4.9	27.3
	9.6	Clay, transported, pink and yellow, plastic	10.5	3.9	28.8
	10.2	Clay, transported, pink and yellow	3.8	5.1	9.5
	13.5	do	5.9	3.3	15.8
	16.2	Clay, transported, pink and yellow, slightly sandy	4.7	2.4	13.7
	16.5	Clay, transported, heavily stained with limonite	5.7	9.9	12.8
	17.3	Clay, transported, pink and yellow, plastic			
	21.0	Clay, transported, yellow, micaceous, interbedded with thin bands of limonite.	8.1	14.7	18.2
	31.0	Clay, transported, pinkish-gray, plastic	11.7	2.8	31.7
Tcl	35.5	Clay, gray, blue, and greenish-blue; residual from basalt.	9.3	4.9	24.9
		Basalt			
		Drill hole Ol-35. Coordinates, 9,050N, 10,935E. Elevation, 2,865 feet			
Qp	14.1	Soil and Palouse formation			
Tlu	25.2	Sand, transported, brownish-gray, slightly micaceous			
	26.2	Clay, transported, gray		1.4	27.9
	30.9	Clay, transported, yellow-gray, sandy		1.4	24.0
	31.8	Clay, transported, dark-yellow; fine-grained gray-streaked sand.		2.2	30.6
	35.2	Clay, transported, gray, yellow-streaked, dry			
	36.3	Clay, transported, yellow		2.5	29.7
	37.7	Clay, transported, yellowish-gray			
	40.7	Sand, transported, yellow, gray-streaked		1.7	12.3
	42.5	Clay, transported, brown, sandy; yellow sandy clay with gray streaks.		6.0	31.2
	46.7	Clay, transported, yellow, gray-streaked			
	47.1	Clay, transported, pinkish-gray-yellow			
	57.1	Clay, transported, pinkish-gray, plastic, white-streaked.		1.9	32.2

Drill hole logs and assay data of the Olson deposit—Continued

Formation	Depth (feet)	Description	Ignition loss	Availability Fe_2O_3	Availability Al_2O_3
		Drill hole Ol-35.—Continued			
Tcl	60.9	Clay; residual from basalt; grayish green, brown-streaked.		6.9	17.9
	65.9	Clay; residual from basalt; light yellow		11.1	12.6
	69.5	do		14.1	10.2
		Basalt			
		Drill hole Ol-36. Coordinates, 8,000N, 12,000E. Elevation, 2,802 feet			
Qp	15.0	Soil and Palouse formation			
Tlu	18.0	Clay, transported, reddish-gray		5.0	23.8
	21.9	Clay, transported, reddish-gray, slightly sandy		5.1	21.2
	23.9	Clay, transported, light-brown		7.0	13.5
	31.3	Clay, transported, pinkish-gray, plastic		2.7	30.5
Tcl	34.0	Clay, residual from basalt, gray		1.1	32.1
	36.4	Clay, residual from basalt, blue		1.4	31.2
	37.6	Clay, residual from basalt, gray			
	45.5	Clay, residual from basalt, blue		1.5	28.3
		Drill hole Ol-37. Coordinates, 9,060N, 10,130E. Elevation, 2,812 feet			
Qp	3.0	Soil and Palouse formation			
Tlu	5.2	Sand, transported, limonite-cemented			
	10.2	Clay, transported, pink, plastic, white-streaked	11.2	2.8	30.4
	11.5	Clay, transported, pink, plastic, brown-streaked			
Tcl	13.7	Clay, blue; residual from basalt	9.2	10.9	21.9
		Basalt			
		Drill hole Ol-38. Coordinates, 6,990N, 12,020E. Elevation, 2,813 feet			
Qp	3.0	Soil and Palouse formation			
Tlu	8.0	Clay, transported, light-brown		5.7	27.0
	10.3	do		6.7	29.9
	15.3	Clay, transported, light-brown, slightly sandy		1.9	26.3
	16.3	Clay, transported, light-gray		1.1	17.7
	17.3	Sand, transported, coarse-grained			
	17.9	Clay, transported, white			
	20.2	Clay, transported, light-brown, sandy		5.7	9.3
	23.8	Clay, transported, light-brown		11.2	25.2
	24.9	Clay, transported, bright-pink and gray		14.1	26.8
	25.8	Clay, transported, light-brown			
	34.6	Clay, transported, gray, plastic		1.9	33.1
Tcl	39.6	Clay; residual from basalt; gray		1.0	33.0
	41.0	Clay; residual from basalt; gray		1.8	30.7
	43.0	Clay; residual from basalt; blue		2.3	30.8
	44.1	Clay; residual from basalt; gray		3.7	29.4
	45.4	Clay; residual from basalt; blue		3.0	26.2
		Drill hole Ol-39. Coordinates, 9,045N, 10,340E. Elevation, 2,845 feet			
Qp	8.0	Soil and Palouse formation; some limonite			
Tlu	10.5	Clay, transported, yellow	10.6	8.0	26.5
	11.8	Clay, transported, yellow, very sandy	8.6	7.1	20.9
	16.3	Clay, transported, yellow and gray	11.0	4.6	28.5
	21.3	Clay, transported, yellow; white sand and mica	4.9	3.1	11.8
	22.3	Clay, transported, yellow; white sand and mica	10.5	14.1	24.0
	32.3	Clay, transported, pink, plastic, gray and white-streaked.	11.9	2.6	31.9
Tcl	34.1	Clay; residual from basalt; blue	9.5	24.2	19.8
		Basalt			

Drill hole logs and assay data of the Olson deposit—Continued

Formation	Depth (feet)	Description	Ignition loss	Availability Fe_2O_3	Availability Al_2O_3
		Drill hole Ol-40. Coordinates, 8,020N, 11,015E. Elevation, 2,863 feet			
Qp	11.0	Soil and Palouse formation			
Tlu	13.5	Sand, transported, limonite-cemented			
	18.5	Clay, transported, yellow and pink	7.2	11.9	16.7
	22.3	Clay, transported, brownish-yellow, sandy	4.6	3.4	11.1
	32.3	Clay, transported, yellow	9.5	4.2	25.4
	36.8	Clay, transported, gray	10.4	2.1	28.7
	39.0	Clay, transported, orange, sandy; thin limonite band	8.3	9.3	20.5
	41.0	Clay, transported, yellow			
	51.0	Clay, transported, pinkish and blue-gray, plastic	12.1	2.6	32.2
	52.5	Clay, transported, pink-gray, plastic			
Tcl	57.5	Clay; residual from basalt; pale green and yellow; hard limonite band.	8.2	18.6	15.8
	62.5	Clay; residual from basalt; yellow			
	72.5	----do	8.3	15.3	16.9
	77.5	Clay; residual from basalt; yellowish brown and blue	8.6	17.4	16.2
	81.1	Clay; residual from basalt; brown and blue	9.1	16.6	19.0
		Basalt			
		Drill hole Ol-41. Coordinates, 10,000N, 11,040E. Elevation, 2,822 feet			
Qp	8.0	Soil and Palouse formation			
Tc		Basalt			
		Drill hole Ol-42. Coordinates, 7,200N, 11,000E. Elevation, 2,768 feet			
Qp	6.8	Soil and Palouse formation			
Tc		Basalt			
		Drill hole Ol-43. Coordinates, 8,085N, 9,270E. Elevation, 2,774 feet			
Qp	9.8	Soil and Palouse formation; bottom portion hard			
Tc		Basalt			
		Drill hole Ol-44. Coordinates, 8,085N, 9,870E. Elevation, 2,824 feet			
Qp	7.5	Soil and Palouse formation			
Tlu	9.2	Clay, transported, gray		2.9	20.4
	10.7	Clay, transported, gray, sandy			
	13.5	Clay, transported, gray and yellow, slightly sandy		2.5	25.3
	16.0	Clay, transported, light-brown		4.1	27.3
	16.8	Clay, transported, light-yellow			
	17.9	Clay, transported, gray and light-brown			
	19.9	Clay, transported, gray and brown, sandy		4.9	13.5
	22.5	Clay, transported, light-brown		16.2	26.7
	32.5	Clay, transported, gray plastic		2.1	32.8
Tcl	37.5	Clay; residual from basalt; gray		7.8	23.2
	41.2	Clay; residual from basalt; greenish-gray		11.0	20.7
	44.1	Clay; residual from basalt; light-brown; dark-brown streaks.		14.3	16.9
	47.3	Clay; residual from basalt; brown		9.2	22.3
	52.1	Clay; residual from basalt; gray		5.7	26.3
	53.0	Clay; residual from basalt; brown		10.0	20.0
		Drill hole Ol-45. Coordinates, 8,090N, 9,470E. Elevation, 2,805 feet			
Qp	9.0	Soil and Palouse formation; bottom portion hard			
Tc	12.0	Basalt			
		Drill hole Ol-46. Coordinates, 7,685N, 9,890E. Elevation, 2,784 feet			
Qp	15.7	Soil and Palouse formation			
Tc		Basalt			

Drill hole logs and assay data of the Olson deposit—Continued

Formation	Depth (feet)	Description	Ignition loss	Availability Fe_2O_3	Availability Al_2O_3
Drill hole Ol-48. Coordinates, 7,690N, 9,500E. Elevation, 2,777 feet					
Qp	16.1	Soil and Palouse formation			
Tc		Basalt			
Drill hole Ol-49. Coordinates, 11,020N, 15,820E. Elevation, 2,794 feet					
Qp	9.7	Soil and Palouse formation; bottom portion hard			
Tlu	13.0	Clay, transported, pinkish-gray, plastic; white streaks		2.5	25.0
Tcl	14.2	Clay; residual from basalt; gray		4.7	23.5
	17.5	Clay; residual from basalt; yellow		14.3	12.9
		Basalt			
Drill hole Ol-50. Coordinates, 10,995N, 15,000E. Elevation, 2,819 feet					
Qp	4.5	Soil and Palouse formation			
Tlu	6.2	Clay, transported, brown, sandy		6.9	16.7
	11.9	Clay, transported, gray; light-brown streaks		4.3	30.4
	18.6	Clay, transported, gray, sandy		1.4	13.4
	23.6	Clay, transported, pinkish-gray, plastic; red-streaked		2.5	29.1
	29.0	Clay, transported, pinkish-gray, plastic			
Tcl	33.0	Clay; residual from basalt; greenish brown		6.2	19.9
Drill hole Ol-51. Coordinates, 10,100N, 15,980E. Elevation, 2,828 feet					
Qp	12.5	Soil and Palouse formation; bottom portion hard			
Tlu	14.5	Sand, transported			
	16.2	Clay, transported, yellow, sandy		1.5	13.7
	17.8	Clay, transported, gray		1.7	31.0
	19.8	Sand, transported, pinkish-brown		1.9	10.3
	24.8	Clay, transported, yellowish-gray, fine-grained sand		5.2	24.4
	25.6	Clay, transported, yellowish-gray			
	26.9	Sand, transported, pale-yellow, micaceous		1.6	12.6
	31.9	Clay, transported, gray and yellow		2.0	25.4
	33.7	Clay, transported, yellow			
	35.5	Clay, transported, pinkish-gray, yellow-spotted			
	40.5	Clay, transported, pinkish-gray, plastic; white streaks.		1.9	33.3
	41.5	Clay, transported, pinkish-gray; white streaks			
Tcl	45.2	Clay; residual from basalt; blue		2.1	32.2
		Basalt			
Drill hole Ol-52. Coordinates, 10,000N, 15,000E. Elevation, 2,809 feet					
Qp	12.3	Soil and Palouse formation			
Tlu	21.1	Clay, transported, pinkish-gray, plastic; white powdery streaks.		2.3	28.9
Tcl	22.0	Clay, residual from basalt, yellow, plastic		4.4	23.8
	23.1	Clay, residual from basalt, blue		5.7	15.9
		Drilling stopped because of hardness.			
Drill hole Ol-53. Coordinates 10,100N, 16,380E. Elevation, 2,781 feet					
Qp	4.0	Soil and Palouse formation; bottom portion hard			
Tc		Basalt			
Drill hole Ol-54. Coordinates 8,000N, 14,950E. Elevation, 2,772 feet					
Qp	3.5	Soil and Palouse formation			
Tc		Basalt			

Drill hole logs and assay data of the Olson deposit—Continued

Formation	Depth (feet)	Description	Ignition loss	Availability Fe_2O_3	Availability Al_2O_3
Drill hole Ol-55. Coordinates, 9,030N, 15,925E. Elevation, 2,810 feet					
Qp	12.0	Soil and Palouse formation; bottom portion hard			
Tcl	14.4	Weathered basalt		7.1	12.0
		Basalt			
Drill hole Ol-56. Coordinates, 8,985N, 14,935E. Elevation, 2,778 feet					
Qp	3.0	Soil and Palouse formation			
Tc		Basalt			
Drill hole Ol-57. Coordinates, 12,100N, 16,025E. Elevation, 2,810 feet					
Qp	22.5	Soil and Palouse formation; bottom portion hard			
Tc		Basalt			
Drill hole Ol-58. Coordinates, 9,010N, 13,910E. Elevation, 2,809 feet					
Qp	11.5	Soil and Palouse formation			
Tcl	16.5	Clay, residual from basalt, grayish blue		3.9	29.7
	17.4	do		5.4	27.5
Drill hole Ol-59. Coordinates, 13,030N, 16,020E. Elevation, 2,834 feet					
Qp	29.3	Soil and Palouse formation; bottom portion hard			
Tc		Basalt			
Drill hole Ol-60. Coordinates, 7,995N, 14,005E. Elevation, 2,804 feet					
Qp	2.9	Soil and Palouse formation			
Tlu	7.3	Clay, transported, pinkish-gray, plastic; white streaks		4.7	32.8
Tcl	10.6	Clay; residual from basalt; yellowish-gray		5.7	33.0
	15.2	Clay; residual from basalt; blue		1.5	31.9
		Basalt			
Drill hole Ol-61. Coordinates, 12,000N, 15,700E. Elevation, 2,817 feet					
Qp	23.5	Soil and Palouse formation			
Tcl	26.0	Decomposed basalt			
		Basalt			
Drill hole Ol-62. Coordinates, 7,000N, 14,015E. Elevation, 2,822 feet					
Qp	16.8	Soil and Palouse formation			
Tlu	18.3	Clay, transported, grayish-brown, plastic		5.9	23.9
	19.5	Clay, transported, dark-brown; some limonite		6.4	12.3
	22.0	Clay, transported, light-brown		4.1	28 9
	23.0	Clay, transported, gray, plastic		2.0	31.9
Tcl	23.7	Clay; residual from basalt; blue		2.9	30.5
Drill hole Ol-63. Coordinates, 15,000N, 15,000E. Elevation, 2,735 feet					
Qp	2.0	Soil and Palouse formation			
Tll	4.7	Clay, transported, yellowish-gray; fine-grained sand		3.3	25.4
	5.8	Sand, transported, yellow-gray		1.7	14.1
	8.5	Clay, transported, dark-gray micaceous sand		4.2	22.0
	13.5	Clay, transported, yellow; gray-streaks		1.6	20.8
	15.5	Clay, transported, gray; yellow-streaks			
	17.5	Clay, transported, yellowish-gray, sandy		4.2	19.3
	18.5	Clay, transported, yellow, limonite			
	19.4	Clay, transported, yellow, sandy			
	20.0	Clay, transported, gray, plastic			
	22.8	Clay, transported, yellow, sandy			
		Limonite			

Drill hole logs and assay data of the Olson deposit—Continued

Formation	Depth (feet)	Description	Ignition loss	Availability Fe_2O_3	Availability Al_2O_3
Drill hole OI-64. Coordinates, 7,000N, 14,790E. Elevation, 2,794 feet					
Qp	19.0	Soil and Palouse formation			
Tc		Basalt			
Drill hole OI-65. Coordinates, 14,805N, 15,460E. Elevation, 2,745 feet					
Tll	5.0	Clay, transported, yellow-gray, sandy		2.1	20.6
		do			
	12.5	Clay, transported, brownish gray, sandy, micaceous			
	14.0	Clay, transported, gray, sandy			
	16.3	Sand, transported, yellow; thin beds of clay			
Drill hole OI-66. Coordinates, 13,995N, 9,035E. Elevation, 2,849 feet					
Qp	35.0	Soil and Palouse formation			
Tlu	37.7	Clay, transported, yellow-gray, plastic		1.9	31.8
	39.4	Clay, transported, pinkish-gray, plastic; white streaks		1.4	26.2
Tcl	41.8	Clay, residual from basalt; blue		2.8	26.9
	45.0	Clay; residual from basalt; yellow-gray		1.9	27.5
	50.7	Clay; residual from basalt; blue		6.1	27.0
	54.0	Clay; residual from basalt; greenish-blue			
	56.6	Clay; residual from basalt		2.7	20.5
	60.3	Clay; residual from basalt; dark gray		8.3	17.3
	61.1	Clay; residual from basalt; greenish-gray			
		Basalt			
Drill hole OI-67. Coordinates, 15,015N, 7,065E. Elevation, 2,853 feet					
Qp	15.8	Soil and Palouse formation			
Tlu	17.3	Clay, transported, pink to orange, plastic		2.9	22.7
	18.0	Clay, transported, brick-red		10.7	22.0
	22.0	Clay, transported, yellow to orange, slightly sandy; limonite bands.		3.3	17.1
	32.0	Clay, transported, yellow to orange, micaceous; limonite bands.			
	35.5	Clay, transported, gray, plastic		2.7	21.3
	40.5	Clay, transported, orange to yellow, sandy micaceous; thin limonite bands.		13.0	17.2
	45.0	Clay, transported, orange to yellow, sandy, micaceous			
	50.0	Clay, transported, gray, fine-grained sand		1.1	13.3
	65.0	Clay, transported, gray and yellow; fine-grained sand; limonite bands.		1.6	11.6
	80.0	Sand, transported, gray, mottled, micaceous		0.9	11.3
	84.8	Sand, transported, brown-gray, coarse-grained, quartz; contains mica books.			
Tlu	94.8	Sand, transported, brown-gray, coarse-grained; contains mica books, angular quartz grains.		1.4	11.2
	99.8	Sand, transported, gray-brown, coarse-grained, contains mica books, quartz.			
	112.7	do		1.8	11.9
	117.2	Clay, transported, tan, sandy, plastic, black-specked; contains plant remains.		7.2	17.7
	122.2	Sand, transported, gray-brown, coarse-grained, quartz, and mica.		1.8	10.5
	127.2	Sand, transported, gray-brown, fine-grained, clayey, quartz, and mica.			
	130.8	Clay, transported, gray, fine-grained quartz, micaceous			
	136.9	Clay, transported, tan, plastic; contains plant remains		6.6	20.9
Drill hole OI-68. Coordinates, 14,020N, 8,035E. Elevation, 2,843 feet					
Qp	15.1	Soil and Palouse formation			
Tlu	21.3	Clay, transported, reddish brown		2.6	25.0
	26.3	Clay, transported, pinkish gray, plastic; white powdery streaks.		1.4	29.9
KJg	30.3	Clay; residual from granodiorite; reddish gray; hard limonite streaks.		3.7	18.2
	35.3	Clay; residual from granodiorite; yellow		1.8	18.0
	45.3	do		1.1	17.1
	49.1	do		1.5	16.7
		Granodiorite			

Drill hole logs and assay data of the Olson deposit—Continued

Formation	Depth (feet)	Description	Ignition loss	Availability Fe_2O_3	Availability Al_2O_3
Drill hole OI-69. Coordinates, 14,955N, 10,100E. Elevation, 2,842 feet					
Qp	16.9	Soil and Palouse formation			
Tcl	21.9	Clay; residual from basalt; blue-gray			
		Basalt			
Drill hole OI-70. Coordinates, 14,000N, 7,040E. Elevation, 2,805 feet					
Tlu	1.0	Clay, transported, light-brown		6.9	14.0
	6.0	Clay, transported, light-brown, slightly sandy and micaceous.		2.7	9.7
	9.0	Clay, transported, light-brown, sandy, micaceous		1.9	16.1
	11.7	Clay, transported, light-gray, sandy		0.9	12.1
	16.7	Clay, transported, light-gray almost white, sandy, micaceous.		0.6	13.1
	18.9	Clay, transported, light-gray-white, sandy, micaceous			
	23.3	Sand, transported, coarse; contains some dark-gray clay.		0.8	4.6
	26.8	Clay, transported, white		0.6	13.0
	31.3	Clay, transported, gray, sandy		0.5	7.6
	34.4	Clay, transported, gray, slightly micaceous		0.7	12.3
	41.2	Clay, transported, gray, slightly sandy and micaceous		0.8	13.2
	42.5	Clay, transported, brown, sandy		2.5	5.2
	47.5	Clay, transported, gray, slightly sandy and micaceous		0.7	11.8
	52.5	Clay, transported, gray, slightly sandy and micaceous		0.8	14.1
Tlu	55.6	Clay, transported, gray, plastic		0.7	22.2
	59.0	Clay, transported, gray, sandy		0.9	11.0
	64.0	Clay, transported, gray, plastic		1.9	22.0
KJg	79.0	Clay; residual from granodiorite; gray; sandy; micaceous.		1.1	17.1
	86.8	Clay; residual from granodiorite; brown, very micaceous.		1.8	15.9
Drill hole OI-71. Coordinates, 14,935N, 11,080E. Elevation, 2,797.2 feet					
Qp	8.5	Soil and Palouse formation			
Tcl	13.5	Partially decomposed basalt			
Drill hole OI-72. Coordinates, 12,800N, 8,080E. Elevation, 2,833 feet					
Qp	11.8	Soil and Palouse formation			
Tcl	8–24.5	Clay; residual from basalt		11.6	24.9
		Basalt			
Drill hole OI-73. Coordinates, 14,870N, 12,085E. Elevation, 2,747 feet					
Qp	14.0	Soil and Palouse formation			
Tll	22.6	Clay, transported, gray, plastic		4.0	21.3
	24.1	Clay, transported, black, plastic		3.4	19.5
	25.2	Clay, transported, gray, plastic		5.1	14.0
	29.0	Clay, transported, black, plastic		4.4	14.2
Tcl		Basalt			
Drill hole OI-74. Coordinates, 13,000N, 8,075E. Elevation, 2,835 feet					
Qp	11.0	Soil and Palouse formation			
Tc	11.0	Basalt			

Drill hole logs and assay data of the Olson deposit—Continued

Formation	Depth (feet)	Description	Ignition loss	Availability Fe_2O_3	Availability Al_2O_3
		Drill hole Ol-75. Coordinates, 14,965N, 9,070E. Elevation, 2,852 feet			
Qp	2.4	Soil and Palouse formation			
Tlu	7.4	Clay, transported, yellow-green		4.4	25.5
	12.4	do		2.4	26.8
	13.7	Clay, transported, gray, sandy		1.0	20.4
	16.5	Clay, transported, yellow, sandy			
	21.5	Clay, transported, gray, sandy		2.6	22.5
	36.5	Clay, transported, gray-yellow; water at 26 ft			
	41.5	Clay, transported, yellow			
	48.2	Clay, transported, yellow, sandy		4.4	18.4
	55.0	Clay, transported, gray		2.1	24.8
	55.6	Clay, transported, gray, limonite bands		15.6	24.3
	58.5	Clay, transported, yellow-gray			
	61.2	Clay, transported, yellow-gray, limonite bands			
	63.5	Clay, transported, gray		4.9	23.4
	66.0	Clay, transported, yellow-gray; contains occasional thin limonite bands.		5.6	24.1
Tlu	71.0	Clay, transported, yellow-gray; occasional thin limonite bands.		2.5	20.0
	76.0	Clay, transported, yellow-gray, sandy			
	84.6	do		3.8	25.9
	89.6	Clay, transported, yellow-gray, slightly sandy, occasional thin limonite bands.			
	94.6	Clay, transported, red-yellow, slightly sandy, iron-stained.		5.3	19.9
	99.6	Clay, transported, yellow, occasional limonite bands			
	109.6	Clay, transported, orange-yellow, slightly sandy		5.0	22.3
	114.6	Clay, transported, orange-yellow, gray-streaked			
KJg	124.3	Clay; residual from granodiorite; orange-yellow; gray streaks.		5.7	16.4
		Granodiorite			
		Drill hole Ol-76. Coordinates, 13,200N, 8,070E. Elevation, 2,834 feet			
Qp	9.8	Soil and Palouse formation			
Tlu	12.0	Clay, transported, light-brown		3.9	24.1
	14.6	Clay, transported, gray, plastic		2.4	26.4
	29.6	Clay, transported, light-gray, powdery		2.7	17.9
	40.5	Clay, transported, gray, powdery		2.8	17.6
	42.3	Clay, transported, gray, plastic		3.6	20.6
Tcl		Basalt			
		Drill hole Ol-77. Coordinates, 14,990N, 8,040E. Elevation, 2,867 feet			
Qp	8.5	Soil and Palouse formation			
Tlu	18.5	Clay, transported, gray sandy		0.9	13.3
	28.5	do		1.0	13.3
	33.5	Clay, transported, gray, sandy; thin limonite bands			
	43.5	Clay, transported, gray, sandy; thin limonite bands		1.1	10.6
	48.5	Clay, transported, gray, sandy; very hard			
	56.4	Clay, transported, brown and red; limonite bands, very hard.		3.9	7.6
KJg		Granodiorite			
		Drill hole Ol-78. Coordinates, 13,000N, 7,020E. Elevation, 2,808 feet			
Qp	20.8	Soil and Palouse formation			
Tlu	25.8	Clay, transported, gray, sandy, micaceous		1.1	14.0
	30.8	Clay, transported, gray, plastic		1.2	18.6
	35.8	do		1.2	19.3
	37.0	Clay, transported, gray, slightly sandy			
	38.5	Clay, transported, gray; coarse-grained sand		0.8	13.9
	43.5	Clay, transported, gray, slightly sandy and micaceous			
	48.5	do		0.7	10.0
	50.1	Clay, transported, gray, sandy			
	61.0	Clay, transported, gray, slightly sandy and micaceous		1.0	14.4
Tcl	61.8	Clay; residual from basalt; brown		6.0	10.5
		Basalt			

Drill hole logs and assay data of the Olson deposit—Continued

Formation	Depth (feet)	Description	Ignition loss	Availability Fe_2O_3	Availability Al_2O_3
Drill hole OI-79. Coordinates, 16,995N, 7,120E. Elevation, 2,876 feet					
Qp	20.0	Soil and Palouse formation			
KJg		Granodiorite			
Drill hole OI-80. Coordinates, 13,000N, 6,050E. Elevation, 2,832 feet					
Qp	3.0	Soil and Palouse formation			
KJg	5.5	Granite, partially weathered			
		Granodiorite			
Drill hole OI-81. Coordinates, 17,990N, 7,170E. Elevation, 2,754 feet					
Qp	3.5	Soil and Palouse formation			
KJg		Granodiorite			
Drill hole OI-82. Coordinates, 14,010N, 6,050E. Elevation, 2,855 feet					
Qp	18.5	Soil and Palouse formation			
KJg	23.5	Clay; residual from granodiorite; gray and red, sandy		1.8	14.0
	28.5	Clay; residual from granodiorite; gray, sandy			
	33.5	do		0.7	13.9
	36.5	Clay; residual from granodiorite; gray			
	52.7	Clay; residual from granodiorite; light brown, slightly sandy.		1.8	14.3
	67.2	Clay; residual from granodiorite; gray, small mica flakes, coarse angular quartz grains.		0.7	12.1
	70.2	Clay; residual from granodiorite; light brown, sandy and micaceous.		1.3	10.6
	77.0	Clay; residual from granodiorite; gray, sandy, slightly micaceous.		0.7	11.3
	81.3	Clay; residual from granodiorite; brown and gray, sandy.		1.1	8.3
	83.0	Clay; residual from granodiorite; brown			
	89.2	Clay; residual from granodiorite; brown, sandy, micaceous.		1.3	11.6
	94.2	Clay; residual from granodiorite; gray, coarse angular quartz grains.		1.8	6.5
	104.2	Clay; residual from granodiorite; gray, very sandy			
KJg	109.2	Clay; residual from granodiorite; gray, very sandy			
	111.2	Clay; residual from granodiorite; dark gray, very sandy.		0.9	10.2
Drill hole OI-83. Coordinates, 16,985N, 8,110E. Elevation, 2,709 feet					
Qp	11.0	Soil and Palouse formation			
KJg		Granodiorite			
Drill hole OI-84. Coordinates, 14,025N, 5,050E. Elevation, 2,863 feet					
Qp	18.5	Soil and Palouse formation			
KJg	33.5	Clay; residual from granodiorite; gray, very sandy		1.4	10.9
	40.6	do			
	45.6	Clay; residual from granodiorite; gray, fine-grained sand.		1.7	13.2
	57.7	do		1.7	12.8
		Granodiorite			
Drill hole OI-85. Coordinates, 16,965N, 9,110E. Elevation, 2,698 feet					
Qp	8.5	Soil and Palouse formation			
KJg		Granodiorite			

Drill hole logs and assay data of the Olson deposit—Continued

Formation	Depth (feet)	Description	Ignition loss	Availability Fe_2O_3	Availability Al_2O_3
Drill hole Ol-86. Coordinates, 15,080N, 5,125E. Elevation, 2,845 feet					
Qp	11.8	Soil and Palouse formation			
KJg		Granodiorite			
Drill hole Ol-87. Coordinates, 17,965N, 8,120E. Elevation, 2,702 feet					
Qp	7.5	Soil and Palouse formation			
KJg		Granodiorite			
Drill hole Ol-88. Coordinates, 15,050N, 6,065E. Elevation, 2,874 feet					
Qp	3.3	Soil		4.1	6.8
	13.3	Palouse formation; very hard		4.6	7.4
	20.0	do		4.1	7.1
KJg	40.0	Clay, residual from granodiorite; light-gray to tan; very fine quartz grains, micaceous.		1.8	12.3
	45.0	do			
	55.0	Clay, residual from granodiorite, light-brown; fine quartz grains, micaceous.		0.7	9.7
	66.7	do		0.7	6.3
		Granodiorite			
Drill hole Ol-89. Coordinates, 18,955N, 8,300E. Elevation, 2,779 feet					
Qp	8.8	Soil and Palouse formation			
KJg		Granodiorite			
Drill hole Ol-90. Coordinates, 16,010N, 7,065E. Elevation, 2,847 feet					
Qp	10.0	Soil and Palouse formation		3.6	7.1
	15.0	Palouse formation		4.0	12.0
Tlu	16.2	Sand, transported, gray, coarse-grained		2.4	11.8
	31.2	Sand, transported, fine-grained, micaceous, clayey, some quartz pebbles.		1.0	9.8
	46.2	do		1.0	10.5
	51.2	do			
	56.2	Clay, transported, yellow, sandy		0.9	9.8
	61.2	Clay, transported, gray, sandy			
	63.8	Clay, transported, yellowish white			
KJg		Granodiorite			
Drill hole Ol-91. Coordinates, 17,920N, 10,145E. Elevation, 2,757 feet					
Qp	5.0	Soil and Palouse formation		4.3	13.3
	10.0	Palouse formation		5.0	11.0
	11.9	do		5.2	11.7
Tlu	13.5	Clay, transported, red-brown		7.7	17.9
	16.8	Clay, transported, gray, plastic		3.4	16.8
	21.8	Clay, transported, orange		2.6	15.3
	26.8	Clay, transported, orange to gray; some limonite bands			
	31.8	Clay, transported, gray; limonite bands		3.1	14.6
	36.8	Clay, transported, yellowto gray, sandy			
	43.0	do		2.0	13.8
Drill hole Ol-92. Coordinates, 17,870N, 11,150E. Elevation, 2,831 feet					
Qp	24.7	Soil and Palouse formation			
Tcl	26.6	Clay; residual from basalt; green-gray	11.6	7.1	29.3
	28.4	do	11.6	4.8	31.8
	37.5	Clay; residual from basalt; gray	10.6	11.7	27.3
	40.0	Clay; residual from basalt; green-gray	10.5	12.2	25.6
	42.5	Clay; residual from basalt; yellow-brown	10.2	17.4	25.8
	43.4	Clay; residual from basalt; gray	9.0	10.0	24.4
		Basalt			

Drill hole logs and assay data of the Olson deposit—Continued

Formation	Depth (feet)	Description	Ignition loss	Availability Fe_2O_3	Availability Al_2O_3
Drill hole OI-93. Coordinates, 16,940N, 10,130E. Elevation, 2,734 feet					
Qp	15.0	Soil and Palouse formation		5.2	8.5
	22.2	Palouse formation		8.8	11.2
Tlu	27.2	Clay, transported, light-yellow, plastic			
	28.5	Clay, transported, light-tan, micaceous		2.8	21.7
KJg	33.5	Clay; residual from granodiorite; gray; micaceous; plastic.		5.1	17.4
	38.5	Sand; residual from granodiorite; gray-brown, micaceous.		9.0	16.8
	48.5	Clay; residual from granodiorite; gray-brown, micaceous, plastic.			
	58.5	do		7.6	10.5
Drill hole OI-94. Coordinates, 16,880N, 11,120E. Elevation, 2,830 feet					
Qp	5.0	Soil and Palouse formation		4.0	6.2
	11.7	Palouse formation		4.4	9.6
Tlu	21.7	Clay, transported, yellowish-gray, sandy		1.0	17.5
	36.7	Clay, transported, gray, sandy		0.7	16.7
	46.7	Clay, transported, yellow to gray, sandy		1.0	17.3
	51.7	do			
KJg	61.7	Clay; residual from granodiorite; yellow-gray, sandy		0.6	16.3
	76.7	do		1.2	15.9
	96.7	Clay; residual from granodiorite; yellow to gray, sandy		2.0	19.2
	99.6	Clay residual from granodiorite; yellow to gray, sandy limonite bands.			
	102.0	Clay; residual from granodiorite; gray-white, sandy		1.2	17.1
	107.0	Clay; residual from granodiorite; gray and yellow, sandy, plastic.		2.3	12.3
	117.0	Clay; residual from granodiorite; yellow, sandy		4.1	14.5
Drill hole OI-95. Coordinates, 15,960N, 10,110E. Elevation, 2,692 feet					
Qp	6.0	Soil and Palouse formation			
Tcl		Basalt			
Drill hole OI-96. Coordinates, 15,910N, 11,120E. Elevation, 2,757 feet					
Qp	21.4	Soil and Palouse formation			
Tll	23.1	Clay, transported, white, micaceous		5.6	22.3
	27.4	Clay, transported, pink and tan, plastic		1.7	18.9
	29.8	Clay, transported, blue		1.3	15.1
	33.6	Clay, transported, black, plastic		1.8	14.5
Tcl		Basalt			
Drill hole OI-97. Coordinates, 17,935N, 9,120E. Elevation, 2,738 feet					
Qp	3.8	Soil and Palouse formation		2.9	7.3
KJg	8.8	Clay; residual from granodiorite; gray, brown-streaked		2.9	8.2
	12.9	do		1.8	6.3
		Granodiorite			
Drill hole OI-98. Coordinates, 13,465N, 10,025E. Elevation, 2,805 feet					
Qp	6.5	Soil and Palouse formation			
Tc		Basalt			
Drill hole OI-99. Coordinates, 13,480N, 9,545E. Elevation, 2,831 feet					
Qp	17.5	Soil and Palouse formation			
Tcl	22.5	Clay; residual from basalt; green-blue	10.0	11.9	22.6
		Basalt			

Drill hole logs and assay data of the Olson deposit—Continued

Formation	Depth (feet)	Description	Ignition loss	Availability Fe_2O_3	Availability Al_2O_3
Drill hole Ol-100. Coordinates, 18,915N, 10,165E. Elevation, 2,839 feet					
Qp	5.0	Soil and Palouse formation		4.3	7.7
	9.2	Palouse formation		4.0	6.2
KJg	14.2	Clay; residual from granodiorite; light-brown, powdery.		3.1	18.5
	29.2	do		3.8	17.5
	44.2	do		3.4	13.9
	64.2	Clay; residual from granodiorite; light brown, slightly micaceous, gray and white streaks.		3.5	15.3
	79.2	do		3.5	12.2
	83.3	do			
	88.3	Sand; residual from granodiorite; some gray and brown gravel.		2.3	5.1
	95.4	Sand; residual from granodiorite; gray and light-brown; some gravel.			
		Granodiorite			
Drill hole Ol-101. Coordinates 18,945N, 9,155E. Elevation, 2,796 feet					
Qp	11.7	Soil and Palouse formation			
KJg		Granodiorite			
Drill hole Ol-102. Coordinates, 19,910N, 10,190E. Elevation, 2,803 feet					
Qp	7.0	Soil and Palouse formation			
KJg	8.8	Partially weathered granodiorite rock			
		Granodiorite			
Drill hole Ol-103. Coordinates, 15,995N, 9,100E. Elevation, 2,720 feet					
Qp	15.0	Soil and Palouse formation		4.4	10.4
	19.9	Palouse formation		4.0	6.4
Tlu	24.9	Clay, transported, gray-brown, plastic; bottom part sandy.		3.8	5.5
Drill hole Ol-104. Coordinates, 16,040N, 8,115E. Elevation, 2,783 feet					
Qp	15.0	Soil and Palouse formation		4.0	8.0
	29.5	Palouse formation		4.0	6.2
KJg	39.5	Clay; residual from granodiorite; gray-brown; sandy		4.0	5.2
		Granodiorite			
Drill hole Ol-105. Coordinates 13,440N, 8,060E. Elevation, 2,847 feet					
Qp	7.4	Soil and Palouse formation			
Tlu	8.9	Clay, transported, gray and yellow	10.7	2.8	30.4
	13.9	Clay, transported, green-gray; narrow brown bands	10.3	4.4	28.6
	14.8	Clay, transported, gray			
	15.5	Clay, transported, gray, sandy	8.0	3.0	22.6
	20.0	Clay, transported, gray			
	25.0	Clay, transported, yellow and gray	7.4	5.1	20.4
	27.5	Clay, transported, light-yellow	7.4	4.5	21.6
	32.5	Clay, transported, light-gray	6.6	2.6	18.9
	35.6	Clay, transported, gray			
	40.6	Clay, transported, gray and yellow	8.1	4.4	24.9
	43.0	Clay, transported, yellow	8.2	8.2	19.8
Tcl	43.0	Basalt			

Drill hole logs and assay data of the Olson deposit—Continued

Formation	Depth (feet)	Description	Ignition loss	Availability Fe_2O_3	Availability Al_2O_3
		Drill hole Ol-106. Coordinates, 18,910N, 11,160E. Elevation, 2,836 feet			
Qp	6.6	Soil and Palouse formation			
Tlu	8.2	Clay, transported; blue-streaked	8.7	8.3	23.3
	12.8	Limonite, hard	9.3	34.7	18.9
	17.8	Clay, transported, gray, sandy	10.7	4.7	29.1
	27.8	do	10.3	1.9	29.5
	36.7	do	10.4	1.4	29.0
	41.7	Clay, transported, yellow, sandy, white-streaked	8.8	1.8	23.8
	46.7	Clay, transported, white, sandy			
	56.7	Clay, transported, white, sandy	8.1	1.4	22.6
	66.7	Clay, transported, white, sandy	7.8	1.4	22.4
	67.9	Clay, transported, yellow-white, sandy			
	80.9	Clay, transported, yellow-white, sandy	7.0	1.9	19.4
Kgn	85.9	Clay, red, sandy; residual from granodiorite	6.2	4.1	10.8
	91.4	Clay, red, sandy; residual from granodiorite, limonite			
	93.7	Clay, white, sandy; residual from granodiorite	3.4	2.2	7.9
KJg	96.4	Granodiorite rock, partly decomposed	4.0	5.0	8.5
		Granodiorite			
		Drill hole Ol-107. Coordinates, 13,500N, 8,545E. Elevation, 2,838 feet			
Qp	10.5	Soil and Palouse formation			
Tlu	12.3	Clay, transported, yellow-gray, plastic	10.4	5.6	30.6
	19.4	Limonite; clay, transported, brown	10.0	51.0	12.3
Tcl	23.0	Clay; residual from basalt; brown	9.1	30.0	16.5
	26.3	Clay, residual from basalt; yellow-gray and brown	8.6	24.3	16.0
	28.5	Clay; residual from basalt; brown	7.2	15.3	16.1
		Basalt			
		Drill hole Ol-108. Coordinates, 14,470N, 8,040E. Elevation, 2,870 feet			
Qp	20.5	Soil and Palouse formation			
Tlu	25.5	Clay, transported, yellow-gray, sandy	9.3	2.5	26.3
	30.5	Clay, transported, gray, sandy	8.7	1.1	24.6
	35.5	Clay, transported, yellow-gray,sandy, micaceous			
	47.9	Clay, transported, white, sandy, micaceous	7.3	0.8	21.1
	48.5	Sand, transported, limonite cemented	6.9	13.7	16.4
	49.0	Sand, transported, limonite cemented	5.5	3.8	14.2
	59.0	Clay, transported, yellow, sandy, micaceous			
	64.0	Clay, transported, yellow-white, sandy, micaceous	5.1	2.7	12.8
	67.8	Clay, transported, yellow-white, sandy, micaceous	5.1	1.9	13.9
	72.8	Clay, transported, pink-green, plastic	11.0	10.0	28.0
	77.8	Clay, transported, pink-green, plastic	10.0	10.7	24.9
	81.6	Clay, transported, brown, sandy	8.7	12.5	21.5
	85.3	Clay, transported, yellow-white, sandy micaceous	5.7	5.6	14.7
	91.3	Clay, transported, pink-yellow, plastic, black-speckled.	9.3	12.2	23.9
KJg	101.3	Clay; residual from granodiorite; gray; sandy; micaceous.	4.4	1.8	12.8
	111.3	do	4.3	1.8	12.3
	121.3	do	4.5	2.0	13.0
	131.3	Clay; residual from granodiorite; tan-gray; muscovite; angular quartz grains; small flakes of biotite.	4.6	2.0	12.3
	135.4	Clay; residual from granodiorite; gray; sandy; micaceous granodiorite.	4.3	1.8	11.8
		Granodiorite			
		Drill hole Ol-109. Coordinates, 19,895N, 11,170E. Elevation, 2,813 feet			
Qp	10.0	Soil and Palouse formation		4.0	8.0
	19.3	Palouse formation		4.6	9.8
Tlu	29.3	Clay, transported, light brown		4.0	28.0
	33.5	do		2.0	29.4
	34.0	Sand, transported, limonite cemented		7.0	27.6
	45.2	Clay, transported, yellowish gray, plastic; half-inch limonite bands at 39.0 ft and 42.5 ft.		3.1	29.7
	46.6	Clay, transported, red, plastic		9.9	24.1
	51.6	Clay, transported, greenish-brown, plastic		6.0	30.0
	56.6	Clay, transported, dark-brown, limonite bands			
	61.6	do		19.6	22.4

Drill hole logs and assay data of the Olson deposit—Continued

Formation	Depth (feet)	Description	Ignition loss	Availability Fe_2O_3	Availability Al_2O_3
Drill hole OI-109—Continued					
Tlu	71.6	Clay, transported, dark-brown and greenish-brown; half-inch limonite bands are dispersed throughout.		11.9	25.5
	86.6	do		7.4	24.7
	96.6	do		7.3	21.5
KJg	101.6	Clay; residual from granodiorite; dark-brown and greenish-brown; half-inch limonite bands are dispersed throughout.			
	106.6	Clay; residual from granodiorite; dark-brown and greenish brown.		7.5	17.9
	108.5	Clay; residual from granodiorite; gray, micaceous, some limonite.			
Drill hole OI-110. Coordinates, 12,985N, 9,030E. Elevation, 2,818 feet					
Qp	9.0	Soil and Palouse formation			
Tcl	9.4	Partially decomposed basalt			
		Basalt			
Drill hole OI-111. Coordinates, 13,485N, 9,030E. Elevation, 2,832 feet					
Qp	18.0	Soil and Palouse formation			
Tcl	20.0	Clay; residual from basalt; yellow			
	26.8	Clay, residual from basalt; black-brown		9.9	25.0
	27.5	Clay; residual from basalt; yellowish green			
	30.2	Clay; residual from basalt; white; intermixed with blue plastic clay.		1.7	20.3
	33.7	Clay; residual from basalt; white		2.7	16.0
	37.5	do		1.3	17.9
	38.0	Clay; residual from basalt; blue brown		2.8	24.4
		Basalt			
Drill hole OI-112. Coordinates, 10,480N, 11,490E. Elevation, 2,852 feet					
Qp	9.0	Soil and Palouse formation			
Tlu	12.5	Clay, transported, yellow, sandy	11.4	14.8	25.5
	19.8	Clay, transported, gray, plastic	12.4	2.3	32.5
Tcl	24.8	Clay; residual from basalt; blue	11.3	2.4	31.6
		Basalt			
Drill hole OI-113. Coordinates, 10,480N, 11,035E. Elevation, 2,837 feet					
Qp	5.5	Soil and Palouse formation			
Tlu	8.3	Clay, transported, pinkish-gray, plastic	11.7	1.9	32.3
Tcl	16.2	Clay; residual from basalt; yellowish brown	7.9	10.8	20.2
		Basalt			
Drill hole OI-114. Coordinates, 10,000N, 11,550E. Elevation, 2,828 feet					
Qp	2.0	Soil and Palouse formation			
Tcl	7.2	Clay, residual from basalt, blue	9.1	6.3	23.3
		Basalt			
Drill hole OI-115. Coordinates, 9,490N, 11,507E. Elevation, 2,859 feet					
Qp	29.0	Soul and Palouse formation			
Tc	29.4	Basalt			

Drill hole logs and assay data of the Olson deposit—Continued

Formation	Depth (feet)	Description	Ignition loss	Availability Fe_2O_3	Availability Al_2O_3
Drill hole OI-116. Coordinates, 9,485N, 12,000E. Elevation, 2,852 feet					
Qp	8.0	Soil and Palouse formation			
Tlu	13.0	Clay, transported, yellow	8.5	4.4	21.8
	17.0	Clay, transported, yellow, sandy; hard limonite band	5.2	5.7	11.7
	21.0	Clay, transported, yellow	11.2	21.1	24.8
	31.0	Clay, transported, pinkish-gray, plastic, white-streaked.	12.5	2.3	32.7
Tcl	38.9	Clay; residual from basalt; yellow	6.8	11.2	14.8
		Basalt			
Drill hole OI-117. Coordinates, 9,035N, 11,510E. Elevation, 2,857 feet					
Qp	19.0	Soil and Palouse formation			
Tlu	21.6	Sand, transported, micaceous			
	26.6	Clay, transported, white	9.0	4.7	23.9
	31.6	Clay, transported, white and yellow			
	34.0	Clay, transported, yellow, some limonite			
	41.7	Clay, transported, pink, plastic	11.8	2.3	31.9
Tcl	42.7	Clay; residual from basalt; blue	10.5	3.8	28.8
	43.7	Clay; residual from basalt; yellow			
	48.3	Clay; residual from basalt; blue			
	53.0	Clay; residual from basalt; yellow			
	54.5	Clay; residual from basalt; blue	7.1	7.7	17.1
		Basalt			
Drill hole OI-118. Coordinates, 9,510N, 11,020E. Elevation, 2,850 feet					
Qp	27.2	Soil and Palouse formation			
Tc		Basalt			
Drill hole OI-119. Coordinates, 9,475N, 10,520E. Elevation, 2,818 feet					
Qp	11.0	Soil and Palouse formation			
Tc		Basalt			
Drill hole OI-120. Coordinates, 8,500N, 11,500E. Elevation, 2,865 feet					
Qp	16.3	Soil and Palouse formation			
Tlu	17.8	Limonite			
	27.6	Sand, transported, micaceous, slightly clayey	2.4	2.3	6.5
	32.6	Clay, transported, yellow	9.1	5.5	25.1
	35.3	Clay, transported, yellow-gray, pink-streaked			
	39.3	Clay, transported, yellowish-gray, sandy, micaceous	8.7	3.0	23.6
	43.5	Clay, transported, dark-yellow, sandy	8.6	4.0	24.0
	48.5	Clay, transported, yellow, gray-streaked, plastic, crumbly.			
	50.0	Clay, transported, yellow, dry and crumbly	15.2	2.5	14.3
	51.5	Clay, transported, light-yellow, very sandy			
	54.2	Clay, transported, grayish-yellow, sandy			
	58.1	Clay, transported, yellow	10.7	15.3	25.7
	67.5	Clay, transported, pinkish-gray, plastic, white-streaked.	12.6	2.3	30.9
Tcl	72.5	Clay; residual from basalt; blue, yellow-gray streaks	11.1	2.0	30.6
	77.5	Clay; residual from basalt; yellow-gray-blue	7.0	8.3	14.1
	85.0	Clay; residual from basalt; yellow	5.6	9.0	10.2
		Basalt			
Drill hole OI-121. Coordinates, 8,500N, 11,020E. Elevation, 2,852 feet					
Qp	15.5	Soil and Palouse formation			
Tlu	20.5	Clay, transported, yellow, sandy, white-streaked	7.7	4.7	20.1
	25.4	Clay, transported, yellow, sandy, white-streaked	10.2	4.0	27.4
	28.5	Sand, transported, limonite cemented	6.7	15.7	13.5
	53.1	Clay, transported, yellow, white and pink-streaked	11.5	11.2	28.4
	41.1	Clay, transported, pink, plastic, white-streaked	12.2	2.0	33.6
Tcl	51.1	Clay; residual from basalt; yellow	7.3	21.5	16.2
	61.1	Clay; residual from basalt; yellow, blue-streaked	7.4	18.5	14.7
	68.3	----do	7.2	12.4	17.0
		Basalt			

Drill hole logs and assay data of the Olson deposit—Continued

Formation	Depth (feet)	Description	Ignition loss	Availability Fe_2O_3	Availability Al_2O_3
		Drill hole Ol–122. Coordinates, 8,495N, 10,535E. Elevation, 2,860 feet			
Qp	11.0	Soil and Palouse formation, some limonite			
Tlu	15.1	Clay, transported, dark-red and yellow, sandy	5.4	11.1	11.4
	20.1	Clay, transported, yellow	8.2	6.3	20.9
	26.4	Sand, transported, yellowish-brown, limonite bands	4.0	7.7	8.3
	38.0	Clay, transported, yellow	8.2	4.6	20.8
	40.0	Sand, transported, yellow			
	49.4	Clay, transported, yellow	11.5	8.2	28.2
	57.0	Clay, transported, pink-gray, plastic, white-streaked	12.5	1.7	33.3
Tcl	62.0	Clay; residual from basalt; yellow-gray and blue			
	70.6	Clay; residual from basalt; yellow-gray	8.2	11.5	17.8
		Basalt			
		Drill hole Ol–123. Coordinates, 8,003N, 11,525E. Elevation, 2,854 feet			
Tlu	8.0	Sand, transported, limonite cemented			
	10.2	Clay, transported, yellow, sandy; thin limonite bands	3.6	8.0	7.0
	15.2	Clay, transported, yellow	9.2	6.0	24.4
	20.2	Clay, transported, yellow, sandy, micaceous	8.0	4.6	21.4
	25.2	Clay, transported, yellow and pink, plastic			
	29.5	Clay, transported, yellow	9.8	2.8	28.0
	33.7	Clay, transported, very sandy	3.1	1.3	4.4
	36.5	Clay, transported, light-yellow and gray	7.1	1.5	19.8
	37.0	Clay, transported, yellow, sandy			
	42.0	Clay, transported, yellow, plastic	11.8	10.9	23.4
	47.0	Clay, transported, pinkish-gray and dark-brown, plastic.	15.0	2.6	32.2
	52.0	Clay, transported, dark-brown, plastic			
Tcl	57.0	Clay; residual from basalt; gray, brown, and pale green.	8.1	19.9	17.0
	62.0	----do	7.7	18.6	15.9
	67.0	Clay; residual from basalt; brown-yellow			
	77.0	Clay; residual from basalt; yellow	8.4	13.7	19.2
	83.3	----do	7.7	16.6	13.2
		Basalt			
		Drill hole Ol–124. Coordinates, 8,500N, 12,000E. Elevation, 2,839 feet			
Qp	14.0	Soil and Palouse formation			
Tlu	15.7	Sand, transported, yellow	3.8	4.1	8.6
	20.7	Clay, transported, yellow, plastic	7.5	4.1	19.9
	25.7	Clay, transported, grayish-yellow, plastic	9.9	2.6	27.0
	30.0	Clay, transported, grayish-yellow, plastic	6.8	3.0	18.5
	33.5	Clay, transported, yellowish-gray sandy			
	38.5	Clay, transported, yellow, very sandy in spots; streaks of plastic clay.	8.3	10.1	21.0
	41.0	Clay, transported, yellow-gray			
	49.5	Clay, transported, pinkish-gray, plastic, white streaked.	14.4	2.6	27.7
	54.9	Clay, transported, black, plastic; plant material	13.2	3.0	22.8
Tcl	59.5	Clay, residual from basalt, blue	11.1	2.6	26.8
		Drill hole Ol–125. Coordinates, 8,500N, 12,500E. Elevation, 2,854 feet			
Qp	4.5	Soil and Palouse formation			
Tlu	10.0	Sand, transported, red	3.7	3.8	9.9
	15.0	Clay, transported, yellowish-gray, sandy, dry and powdery.	7.0	2.7	19.6
	20.0	Clay, transported, yellowish-gray, sandy			
	27.0	Clay, transported, yellowish-gray, sandy	9.8	3.2	26.9
	28.5	Clay, transported, pinkish-yellow, very sandy	5.2	3.3	14.6
	36.2	Clay, transported, yellowish-gray	10.5	9.2	26.9
	45.0	Clay, transported, pinkish-gray, plastic, white-streaked.	12.2	2.7	32.4
Tcl	55.0	Clay; residual from basalt; blue, greenish-yellow-streaks.	10.9	3.8	29.6
	60.0	----do	8.8	7.3	22.2
	65.0	Clay; residual from basalt; greenish-yellow; 0.7-in. limonite band.			
	72.3	Clay; residual from basalt; greenish-yellow	7.1	8.9	18.1
		Basalt			

Drill hole logs and assay data of the Olson deposit—Continued

Formation	Depth (feet)	Description	Ignition loss	Availability Fe_2O_3	Availability Al_2O_3
Drill hole Ol–125.5. Coordinates, 8,500N, 12,750E. Elevation, 2,851 feet					
Qp	12.2	Soil and Palouse formation			
Tlu	17.2	Clay, transported, yellow, very sandy	5.0	4.5	12.0
	20.9	do	5.1	3.7	13.3
	25.9	Clay, transported, pale-yellow, sandy	6.2	2.3	16.5
	27.2	do	4.6	3.0	12.0
	28.0	Clay, transported, pink	4.4	3.2	11.6
	32.4	Clay, transported, sandy, micaceous, pink-streaked			
	36.2	Clay, transported, yellow, sandy, micaceous	4.3	2.0	11.4
	37.8	Clay, transported, gray, pink-stained, plastic	9.5	2.2	26.0
	38.7	Clay, transported, yellow, very sandy	6.8	6.7	16.5
	39.6	Clay, transported, yellow			
	40.4	Limonite	10.6	43.0	14.1
	44.9	Clay, transported, yellow	11.9	18.6	25.5
	50.8	Clay, transported, light-pink, plastic	12.8	2.2	33.1
Tcl	55.3	Clay; residual from basalt; gray	12.1	1.9	31.0
		Basalt			
Drill hole Ol–126. Coordinates, 8,500N, 12,995E. Elevation, 2,867 feet					
Qp	18.0	Soil and Palouse formation			
Tlu	21.3	Limonite			
	24.5	Sand, transported, limonite colored			
	29.5	Clay, transported, yellow, muscovite and quartz	8.6	4.4	23.8
	34.5	Clay, transported, yellowish-gray, sandy, small muscovite flakes.	9.9	3.1	27.1
	39.5	Clay, transported, yellowish-gray, sandy, small muscovite flakes.	8.5	3.9	22.8
	47.3	Clay, transported, pinkish-yellow, sandy, slightly micaceous.	6.3	4.7	16.8
	51.3	Clay, transported, yellow; contains muscovite flakes, coarse quartz grains, and gray streaks.	9.7	3.6	26.7
	52.2	Clay, transported, brown, limonitic; abundant quartz grains.	8.0	9.2	19.8
	55.5	Clay, transported, yellow, gray-streaked			
	68.2	Clay, transported, pinkish and tannish-gray, plastic; contains fine-grained muscovite and silt.	11.8	2.7	31.9
	73.2	Clay; residual from basalt; blue; grayish-yellow streaks; some small pores filled with white kaolinite and the few small vesicles filled with white kaolinite and some tan palagonitic clay.[5]	11.9	1.4	34.0
	83.2	Clay; residual from basalt; gray-blue; grayish-yellow streaks of palagonitic clay; white kaolinite spots.[5]	11.0	1.6	33.0
	93.2	Clay; residual from basalt; blue-gray; small kaolirite spots; most pores are empty.[6]	10.3	3.4	28.5
	98.2	Clay; residual from basalt; yellow; blue-gray streaks			
	103.2	Clay; residual from basalt; blue-gray, yellow streaks; most openings filled with white kaolinite.	[2] 10.1	3.1	29.0
	113.2	Clay; residual from basalt; blue-gray; streaked with streaked with brown limonite.[5]	10.1	3.5	29.4
	118.2	Clay, blue-gray; residual from basalt; streaked with brown and yellow limonite.	[7] 9.6	3.3	28.0
	124.5	Clay, blue-gray; residual from basalt			
		Basalt			

[5] Gallium content, 0.005 percent.
[6] Gallium content, 0.003 percent.
[7] Gallium content, 0.006 percent.

Formation	Depth (feet)	Description	Ignition loss	Availability Fe_2O_3	Availability Al_2O_3
Drill hole Ol–126.2. Coordinates, 8,250N, 12,995E. Elevation, 2,855 feet					
Qp	13.2	Soil and Palouse formation			
Tlu	18.4	Clay, transported, yellow, plastic	10.3	9.7	24.3
	23.4	do	10.5	4.2	27.8
	26.0	Clay, transported, yellow, plastic, pink-streaked			
	27.3	Clay, transported, yellow, very sandy	6.9	4.6	17.8
	32.3	Clay, transported, yellow, micaceous, pink-streaked	10.3	2.2	28.5
	38.7	Clay, transported, yellow and pink, micaceous sandy	5.3	2.8	14.1
	42.0	Clay, transported, yellow	5.3	3.6	13.6
	44.5	Clay, transported, gray, yellow-streaked, plastic	11.9	7.0	31.6
	45.5	Sand, transported, white and yellow	8.7	10.6	21.2
	49.9	Clay, transported, yellow, plastic; gray and orange streaks.	12.6	10.4	31.7
	57.0	Clay, transported, pink, plastic	12.6	2.6	34.4

Drill hole logs and assay data of the Olson deposit—Continued

Formation	Depth (feet)	Description	Ignition loss	Availability Fe_2O_3	Availability Al_2O_3
		Drill hole Ol-126.2—Continued			
Tcl	62.0	Clay; residual from basalt; blue; yellow-streaked	12.6	1.0	35.2
	67.0	do	12.4	1.7	34.7
	72.0	Clay; residual from basalt; blue	12.6	1.6	34.2
	77.0	do	10.6	3.9	30.3
	87.0	Clay; residual from basalt; yellow and blue; micaceous	8.8	8.4	24.2
	97.0	do	8.9	8.0	24.4
	107.0	Clay; residual from basalt; yellow, brown and blue-streaked.	8.6	7.9	23.1
	112.0	Clay; residual from basalt; brown and yellow			
	118.9	Clay; residual from basalt; yellow; brown and blue	8.9	6.0	25.0
		Basalt			
		Drill hole Ol-126.5. Coordinate, 8,500N, 13,250E. Elevation, 2,864 feet			
Qp	30.7	Soil and Palouse formation			
Tlu	31.8	Sand, transported, orange and pink, micaceous	6.7	2.4	17.7
	35.1	Clay, transported, yellow, micaceous	9.7	3.7	25.6
	37.5	Clay, transported, yellow and gray	12.8	2.7	34.5
	40.5	Clay, transported, yellow, sandy, micaceous	7.3	2.7	19.0
	43.9	Clay, transported, light gray	11.1	1.6	30.8
	46.8	Clay, transported, yellow, sandy	6.3	3.1	16.1
	50.7	Clay, transported, yellow, gray-streaked	11.5	12.5	27.7
	53.8	Clay, transported, yellow, pink and white streaked	12.1	9.0	29.9
	62.2	Clay, transported, pink, plastic, brown-stained	12.6	2.4	33.2
	63.0	Clay, transported, pink and blue, plastic			
Tcl	68.0	Clay, yellow and blue; residual from basalt	11.4	1.3	32.2
	70.3	Clay, blue; residual from basalt	8.6	5.0	23.5
		Basalt			
		Drill hole Ol-127. Coordinate, 9,000N, 13,495E. Elevation, 2,840 feet			
Qp	9.3	Soil and Palouse formation			
Tlu	10.3	Sand, transported, orange			
	18.0	Clay, transported, yellow-gray	10.0	3.6	27.9
	23.0	Clay, transported, gray, sandy	7.7	3.0	21.0
	28.0	Clay, transported, whitish-yellow	11.9	2.9	32.6
	33.0	Clay, transported, yellow, sandy	4.1	0.9	10.6
	36.0	Clay, transported, sandy, limonitic	9.0	10.0	24.0
	41.0	Clay, transported, dark-blue, plastic	11.3	2.3	31.7
	43.5	Clay, transported, pink, plastic			
Tcl	46.0	Clay; residual from basalt; yellow and blue	10.4	2.5	30.6
		Drill hole Ol-128. Coordinates, 7,500N, 11,510E. Elevation, 2,785 feet			
Qp	8.5	Soil and Palouse formation			
Tc		Basalt			
		Drill hole Ol-129. Coordinates, 8,500N, 13,515E. Elevation, 2,855 feet			
Qp	22.5	Soil and Palouse formation			
Tlu	23.8	Sand, transported, cemented by limonite			
	27.5	Sand, transported			
	32.5	Clay, transported, white to yellow	9.7	2.6	26.4
	37.5	Clay, transported, yellow-white, sandy	6.8	3.2	17.8
	42.5	Clay, transported, whitish-yellow	10.8	7.5	28.3
	45.3	Clay, transported, yellow			
	50.3	Clay, transported, pink	11.8	1.9	32.3
	58.0	Clay, transported, pink, plastic			
Tcl	63.0	Clay; residual from basalt; blue	10.9	1.7	31.8
	66.8	Clay; residual from basalt; blue	9.0	4.4	25.8
		Basalt			

Drill hole logs and assay data of the Olson deposit—Continued

Formation	Depth (feet)	Description	Ignition loss	Availability Fe_2O_3	Availability Al_2O_3
		Drill hole Ol-130. Coordinates, 8,500N, 14,010E. Elevation 2,833 feet			
Qp	27.0	Soil and Palouse formation			
Tlu	29.2	Clay, transported, gray	10.5	3.0	27.9
Tcl	37.0	Clay; residual from basalt; blue	9.1	9.0	23.2
		Basalt			
		Drill hole Ol-131. Coordinates, 7,900N, 13,500E. Elevation 2,831 feet			
Qp	10.0	Soil and Palouse formation			
Tlu	11.6	Sand, transported			
	16.6	Clay, transported, yellow-pink, sandy	5.0	2.6	14.2
	21.6	Clay, transported, yellow; 3.6-in. limonite band	10.8	8.5	28.9
	24.5	Clay, transported, white to yellow			
	33.5	Clay, transported, pink, plastic	11.8	1.9	33.2
Tcl	36.6	Clay; residual from basalt; gray; traces of yellow and blue.	12.1	1.0	34.5
	42.0	Clay; residual from basalt; blue	10.9	1.8	32.3
		Basalt			
		Drill hole Ol-132. Coordinates, 7,510N, 13,500E. Elevation 2,812 feet			
Qp	19.8	Soil and Palouse formation			
Tc		Basalt			
		Drill hole Ol-133. Coordinates, 7,500N, 13,995E. Elevation, 2,808 feet			
Qp	22.0	Soil and Palouse formation			
Tcl	25.1	Clay; residual from basalt; blue			
		Basalt	9.4	6.2	26.2
		Drill hole Ol-134. Coordinates, 8,000N, 12,510E. Elevation, 2,806 feet			
Qp	15.5	Soil and Palouse formation			
Tlu	16.5	Limonite			
Tcl	21.5	Clay; residual from basalt; yellow	6.8	17.7	15.4
	24.0	Clay; residual from basalt; blue			
		Basalt			
		Drill hole Ol-135. Coordinates, 7,500N, 12,510E. Elevation, 2,812 feet			
Qp	7.2	Soil and Palouse formation			
Tlu	9.5	Limonite, hard			
	15.8	Clay, transported, yellow, white and pink streaked	12.1	2.4	33.2
	17.7	Clay, transported, dark-gray, yellow, pink, and white streaked.	10.8	15.0	33.3
	25.5	Clay, transported, gray, plastic			
Tcl	30.8	Clay; residual from basalt; gray; blue and yellow streaked.	10.0	3.8	28.5
		Basalt			
		Drill hole Ol-136. Coordinates, 7,500N, 13,000E. Elevation, 2,821 feet			
Qp	21.4	Soil and Palouse formation			
Tlu	25.9	Clay, transported, gray, white and yellow streaked	11.5	2.4	30.6
Tcl	30.9	Clay; residual from basalt; blue	11.6	1.5	31.9
	37.5	Clay; residual from basalt; blue; yellow-streaked	11.0	4.1	29.5
		Basalt			

Drill hole logs and assay data of the Olson deposit—Continued

Formation	Depth (feet)	Description	Ignition loss	Availability Fe_2O_3	Availability Al_2O_3
		Drill hole Ol-137. Coordinates, 7,000N, 12,530E. Elevation, 2,843 feet			
Qp	2.0	Soil and Palouse formation			
Tlu	16.2	Sand, transported, interbedded limonite			
	20.5	Clay, transported, yellow, sandy micaceous, white-streaked.	7.5	3.7	19.7
	21.9	Sand, transported, pink, micaceous	3.2	2.1	7.4
	25.0	Clay, transported, yellow, white-streaked	8.3	4.6	21.8
	26.0	Clay, transported, yellow, sandy			
	31.0	Clay, transported, yellow, white-streaked	9.5	4.5	25.7
	38.5	do	7.5	2.9	21.2
	42.8	Clay, transported, yellow and white, sandy, micaceous	5.7	5.7	15.4
	45.9	Clay, transported, white, plastic; pink, black, brown, and gray streaked.			
	47.0	Limonite			
	52.0	Clay, transported, pink, plastic	9.6	5.6	24.2
	64.9	Clay, transported, pink, plastic	9.5	2.8	23.7
Tcl	68.7	Basalt, incompletely weathered	8.3	19.9	17.9
		Basalt			
		Drill hole Ol-138. Coordinates, 6,510N, 12,525E. Elevation, 2,792 feet			
Qp	7.0	Soil and Palouse formation			
Tcl	12.0	Clay; residual from basalt; dark brown	9.2	18.0	21.2
	17.0	Clay; residual from basalt; brown, yellow-streaked			
	27.0	Partially decomposed basalt	9.2	16.0	21.1
	32.0	Basalt, incompletely decomposed brown	8.9	16.1	20.8
	39.7	do	8.2	16.6	16.0
		Basalt			
		Drill hole Ol-139. Coordinates, 7,000N, 11,530E. Elevation, 2,794 feet			
Qp	17.5	Soil and Palouse formation			
Tcl	22.5	Clay; residual from basalt; yellow, blue-streaked	8.3	16.3	19.3
	26.3	Clay; residual from basalt; blue	8.4	16.9	18.6
		Basalt			
		Drill hole Ol-140. Coordinates, 7,505N, 11,015E. Elevation, 2,835 feet			
Qp	8.0	Soil and Palouse formation			
Tlu	12.7	Clay, transported, yellow, slightly sandy, white-streaked.	9.1	4.2	22.2
	14.8	Clay, transported, yellow, very sandy	8.6	10.4	19.0
	22.1	Clay, transported, pink, plastic, white-streaked	12.4	3.7	31.9
	22.7	Limonite	12.5	13.8	28.5
	23.0	Clay, transported, red, plastic			
Tcl	28.0	Clay; residual from basalt; blue; red-streaked	10.1	28.3	20.7
	33.0	Clay; residual from basalt; yellow; red-streaked	10.0	19.7	21.9
	43.0	Clay; residual from basalt; yellow, blue-streaked	8.9	18.7	20.3
	48.0	Clay; residual from basalt; yellow, blue-streaked	7.7	15.5	18.6
	53.0	Clay; residual from basalt; yellow	7.7	10.6	18.2
	58.0	do	7.7	5.0	19.2
	63.0	Clay; residual from basalt; blue; brown-streaked	8.1	15.0	18.7
	68.0	Clay; residual from basalt; blue; brown-streaked	7.3	9.9	17.7
	73.7	Clay; residual from basalt; yellow, blue-streaked	6.6	6.7	16.9
		Basalt			
		Drill hole Ol-141. Coordinates, 8,990N, 12,500E. Elevation, 2,881 feet			
Qp	11.5	Soil and Palouse formation; very hard			
Tlu	12.0	Sand, transported, orange, limonite cemented, very hard.			
	26.0	Sand, transported, orange			
	29.0	Clay, transported, pink, sandy	5.8	1.5	15.5
	32.8	Sand, transported, orange	2.8	1.8	6.7
	42.8	Clay, transported, yellow	8.5	3.3	22.4
	45.0	Clay, transported, white	6.1	2.0	16.7
	46.0	Sand, transported			

Drill hole logs and assay data of the Olson deposit—Continued

Formation	Depth (feet)	Description	Ignition loss	Availability Fe_2O_3	Availability Al_2O_3
		Drill hole Ol-141—Continued			
Tlu	51.0	Clay, transported, yellow and white, slightly sandy	8.3	1.6	23.4
	55.0	Clay, transported, yellow; last 1.5 feet limonite and brown clay.	9.6	12.9	23.0
	60.0	Clay, transported, pink, plastic	11.1	3.0	29.2
	65.0	Clay, transported, pink and brown, plastic			
Tcl	70.8	Clay; residual from basalt; yellow	8.0	6.6	20.4
		Basalt			
		Drill hole Ol-142. Coordinates, 7,495N, 12,025E. Elevation, 2,783 feet			
Qp	6.6	Soil and Palouse formation			
Tcl	8.0	Clay; residual from basalt; brown	10.5	4.2	27.1
		Basalt			
		Drill hole Ol-143. Coordinates, 10,450N, 10,550E. Elevation, 2,831 feet			
Qp	8.0	Soil and Palouse formation			
Tlu	13.7	Clay, transported, gray, plastic	9.9	4.6	26.0
Tcl	15.0	Clay; residual from basalt; blue	9.3	8.8	25.0
	22.6	Clay; residual from basalt; yellow	6.9	12.2	15.6
		Basalt			
		Drill hole Ol-144. Coordinates, 6,510N, 13,010E. Elevation, 2,845 feet			
Qp	8.0	Soil and Palouse formation			
Tlu	32.6	Sand, transported, pink			
	35.7	Clay, transported, yellow	7.6	4.6	21.4
	39.4	Clay, transported, light-plnk	7.5	1.7	21.8
	44.4	Sand, transported, pink and yellow	3.2	1.8	8.2
	50.2	Clay, transported, yellow, plastic	10.9	7.4	29.4
	51.3	Clay, transported, light-gray, plastic	9.3	23.8	21.5
	53.0	Clay, transported, yellow, very hard limonite			
	59.5	Clay, transported, pinkish-gray and brown	11.5	2.8	32.0
	61.0	Clay, transported, tan-gray, fine-grained muscovite, fine- to medium-grained quartz.	10.1	2.8	29.0
	62.9	Limonite	8.5	19.1	20.1
Tcl		Basalt			
		Drill hole Ol-145. Coordinates, 6,500N, 13,500E. Elevation, 2,864 feet			
Qp	31.0	Soil and Palouse formation			
	36.0	Clay, transported, pink-gray and yellow	7.2	3.4	19.6
Tlu	41.0	Clay, transported, light-yellow; thin sandy beds			
	46.0	Clay, transported, yellow	8.9	2.8	24.3
	50.0	Clay, transported, yellow and gray			
	52.8	Clay, transported, yellow and gray, sandy	6.1	2.4	16.4
	55.5	Clay, transported, yellow and gray			
	57.0	Sand, transported, pink, slightly micaceous	5.1	1.8	13.2
	58.5	Clay, transported, yellow and gray			
	61.0	Clay, transported, yellow			
	62.3	Clay, transported, pinkish-gray			
	64.2	Sand, transported, gray and yellow			
	69.2	Clay, transported, yellow, plastic	11.5	13.5	28.0
	71.2	Clay, transported, yellow, thin limonite band			
	76.2	Clay, transported, pinkish-gray, plastic	12.4	1.9	33.6
	77.2	Clay, transported, gray			
Tcl	82.2	Clay; residual from basalt; blue and gray	10.3	2.7	29.3
	83.3	Clay; residual from basalt; blue			
		Basalt			

Drill hole logs and assay data of the Olson deposit—Continued

Formation	Depth (feet)	Description	Ignition loss	Availability Fe_2O_3	Availability Al_2O_3
		Drill hole Ol-146. Coordinates, 6,500N, 14,000E. Elevation, 2,852 feet			
Qp	4.0	Soil and Palouse formation			
Tlu	5.4	Sand, transported, limonite cemented, very hard			
	9.2	Clay, transported, yellow to pink, slightly micaceous	9.0	3.2	24.1
	14.2	Sand, transported, pink, micaceous			
	19.2	Sand, transported, pink; hard limonite from 18.0–18.6 ft.		10.0	20.0
	22.2	Sand, transported, pink, fine- and coarse-grained			
	27.2	Clay, transported, yellow-white	9.0	3.0	25.2
	29.2	Clay, transported, sandy	5.2	2.4	13.6
	33.7	Clay, transported, gray	8.2	2.2	22.9
	35.0	Clay, transported, yellow, sandy	7.0	2.8	18.4
	37.8	Clay, transported, light yellow			
	40.0	Clay, transported, yellow, sandy			
	42.9	Clay, transported, gray	5.4	4.0	13.9
	44.2	Clay, transported, yellow; sandy; limonite last 0.2 ft			
	48.3	Clay, transported, gray, plastic	10.5	6.3	28.4
	55.0	Clay, transported, pinkish-gray, plastic; white streaks	12.3	2.5	33.7
	56.2	Limonite	9.9	57.5	12.4
		Drill hole Ol-147. Coordinates, 7,000N, 13,515E. Elevation, 2,832 feet			
Qp	24.0	Soil and Palouse formation			
Tlu	26.2	Clay, transported, yellow, limonite, sandy	5.3	6.5	14.7
	27.2	Clay, transported, yellow	8.7	5.9	24.0
	35.0	Clay, transported, light-gray	11.0	1.6	31.4
	40.0	Clay, transported, yellow; thin limonite band	11.6	16.8	27.4
	45.0	Clay, transported, pink, plastic	12.7	1.9	34.0
	46.5	Clay, transported, pinkish-gray, plastic			
Tcl	51.5	Clay; residual from basalt; blue, gray streaks	12.1	2.4	33.5
	56.5	Clay; residual from basalt; yellow	9.3	11.5	21.2
	67.5	Clay; residual from basalt; yellow	8.5	14.4	18.2
	72.5	Clay; residual from basalt	7.9	8.0	21.0
	76.5	Clay; residual from basalt; blue, yellow, gray and tan			
		Basalt			
		Drill hole Ol-148. Coordinates, 10,480N, 12,000E. Elevation, 2,862 feet			
Qp	3.5	Soil and Palouse formation			
Tlu	5.5	Sand, transported, coarse-grained			
	11.4	Clay, transported, red and quartz sand	3.8	1.9	10.1
	14.0	Clay, transported, tan and white, plastic	9.5	5.4	24.3
	24.0	Clay, transported, pink, plastic, white-streaked	8.2	3.1	21.7
	27.5	Clay, transported, pink and white, plastic	10.2	2.2	27.0
	32.5	Clay, transported, yellow, sandy	4.1	1.9	9.8
	33.5	Clay, transported, white, plastic	9.1	12.1	23.5
	34.0	Clay, transported, sandy			
	36.4	Clay, transported, tan and white, plastic			
	36.7	Limonite			
	39.7	Clay, transported, yellow, plastic			
	49.7	Clay, transported, gray, plastic	11.1	2.3	30.9
	54.7	Clay, transported, gray	8.7	2.4	24.0
	56.4	Clay, transported, blue	6.2	3.5	17.5
Tcl		Basalt			
		Drill hole Ol-149. Coordinates, 9,485N, 12,500E. Elevation, 2,868 feet			
Qp	8.5	Soil and Palouse formation			
Tlu	13.0	Clay, transported, yellow, plastic	7.0	2.6	18.5
	15.0	Sand, transported, orange			
	17.9	Clay, transported, yellow, sandy	6.8	2.2	17.2
	19.2	Clay, transported, pink and yellow, plastic			
	20.7	Sand, transported, yellow			
	24.5	Clay, transported, yellow	10.0	2.1	26.4
	31.2	Sand, transported, orange	5.4	3.3	13.2
	36.2	Sand, transported, orange; streaked with pink plastic clay.			
	38.5	Clay, transported, gray and yellow; sandy; two thin limonite bands.	9.6	13.0	21.3
	41.6	Clay, transported, yellow, thin; hard limonite band			
	51.5	Clay, transported, pinkish-gray, plastic, white-streaked.	12.4	2.4	32.8
Tcl	57.8	Clay; residual from basalt; yellow	8.4	8.0	18.2
		Basalt			

Drill hole logs and assay data of the Olson deposit—Continued

Formation	Depth (feet)	Description	Ignition loss	Availability Fe_2O_3	Availability Al_2O_3
Drill hole Ol-150. Coordinates, 10,000N, 12,500E. Elevation, 2,860 feet					
Qp	4.8	Soil and Palouse formation			
Tlu	9.8	Clay, transported, yellow, very sandy	6.8	2.9	17.7
	17.0	do	2.7	3.9	6.1
	22.0	Clay, transported, yellow, slightly sandy, pink-streaked.	7.9	5.4	20.0
	26.4	Clay, transported, gray, white- and pink-streaked	10.2	3.7	26.9
	31.4	Clay, transported, yellow, sandy, slightly micaceous	4.9	2.2	12.4
	32.9	Sand, transported, limonite-cemented	4.2	7.6	9.6
	37.0	Clay, transported, yellow, slightly sandy	10.3	13.7	23.5
	38.5	Clay, transported, pink, plastic, white-streaked			
	43.5	Clay, transported, dark-gray, plastic	10.9	2.8	29.1
	46.4	Clay, transported, pink, plastic			
Tcl	50.0	Clay; residual from basalt; yellow	7.0	7.8	15.1
		Basalt			
Drill hole Ol-151. Coordinates, 9,485N, 13,000E. Elevation, 2,834 feet					
Qp	12.7	Soil and Palouse formation			
Tlu	15.8	Clay, transported, yellow, slightly sandy, white-streaked.	11.0	11.2	28.0
	17.4	Clay, transported, gray, yellow-streaked	11.4	2.3	31.5
	22.4	Clay, transported, light-pink, plastic, white-streaked	11.6	2.4	32.4
Tcl	27.5	Clay; residual from basalt; blue	9.5	4.7	26.0
		Basalt			
Drill hole Ol-152. Coordinates, 9,485N, 13,500E. Elevation, 2,830 feet					
Qp	23.1	Soil and Palouse formation			
Tlu	24.7	Clay, transported, yellow, white-streaked	7.3	5.3	18.5
	27.1	Clay, transported, yellow, very sandy			
	36.6	Clay, transported, pink, plastic, yellow- and white-streaked.	11.7	4.0	29.8
Tcl	46.6	Clay; residual from basalt; yellow	8.9	5.7	23.7
	55.4	Clay; residual from basalt; yellow	8.8	7.8	22.3
		Basalt			
Drill hole Ol-152.5. Coordinates, 9,480N, 13,750E. Elevation, 2,819 feet					
Qp	24.8	Soil and Palouse formation			
Tcl	28.7	Clay; residual from basalt; blue	8.5	7.2	22.0
		Basalt			
Drill hole Ol-153. Coordinates, 9,495N, 14,000E. Elevation, 2,802 feet					
Qp	11.3	Soil and Palouse formation			
Tcl	14.2	Clay; residual from basalt; blue	7.4	10.0	18.5
		Basalt			
Drill hole Ol-154. Coordinates, 10,000N, 13,500E. Elevation, 2,809 feet					
Qp	9.9	Soil and Palouse formation			
Tlu	17.3	Clay, transported, pink, plastic	11.9	3.4	30.2
Tcl	22.3	Clay; residual from basalt; yellow	8.9	6.5	20.9
	26.9	do	8.2	8.6	18.5
		Basalt			

Drill hole logs and assay data of the Olson deposit—Continued

Formation	Depth (feet)	Description	Ignition loss	Availability Fe_2O_3	Availability Al_2O_3
Drill hole OI-155. Coordinates, 10,500N, 12,500E. Elevation, 2,859 feet					
Qp	6.0	Soil and Palouse formation			
Tlu	11.0	Clay, transported, red, sandy	3.6	2.6	7.6
	21.0	do	4.4	3.3	10.4
	26.0	do	9.9	4.1	26.8
	30.0	do	6.2	2.4	17.1
	31.0	Clay, transported, gray, plastic	4.9	3.7	12.7
	35.0	Clay, transported, yellow, sandy			
	40.0	Clay, transported, gray, plastic	10.2	2.9	28.3
	43.2	Clay, transported, white, sandy	3.6	1.6	9.5
	43.6	Limonite	9.8	17.7	21.7
	44.2	Clay, transported, gray, plastic			
	47.9	Clay, transported, yellow, plastic			
	57.9	Clay, transported, dark-gray, plastic	12.0	2.4	33.0
Tcl	61.0	Clay; residual from basalt; gray	9.2	3.7	25.9
	62.4	Clay; residual from basalt; blue	7.5	5.4	19.9
		Basalt			
Drill hole OI-156. Coordinates, 10,500N, 12,990E. Elevation, 2,837 feet					
Qp	26.5	Soil and Palouse formation			
Tlu	28.4	Clay, transported, yellow, sandy	7.0	5.0	18.2
	33.4	Clay, transported, yellow, plastic	11.2	11.7	27.7
	45.2	Clay, transported, gray, plastic	12.0	2.4	32.7
Tcl	48.0	Clay; residual from basalt; blue	11.6	2.3	31.9
	53.0	Clay; residual from basalt; greenish-gray	9.0	6.3	20.9
	57.0	Clay; residual from basalt; blue	8.7	8.5	18.8
		Basalt			
Drill hole OI-157. Coordinates, 10,500N, 13,490E. Elevation, 2,805 feet					
Qp	6.3	Soil and Palouse formation			
Tlu	12.8	Clay, transported, gray, plastic, yellow- and white-streaked.	11.6	2.6	32.0
Tcl	17.8	Clay; residual from basalt; yellow; blue-streaked	9.6	6.5	25.0
	25.1	Clay; residual from basalt; yellow; blue-streaked	8.1	9.9	17.6
		Basalt			
Drill hole OI-158. Coordinates, 10,500N, 14,000E. Elevation, 2,831 feet					
Qp	25.6	Soil and Palouse formation			
Tlu	28.3	Sand, transported; very coarse grained quartz			
	29.9	Clay, transported, yellow	10.3	12.8	23.4
	34.9	Clay, transported, gray, white- and brown-streaked	12.1	2.7	33.2
	39.9	Clay, transported, gray, plastic, pink- and white-streaked.			
	41.4	Clay, transported, pink, plastic, white-streaked			
Tcl	46.9	Clay; residual from basalt; blue	9.7	6.6	25.5
		Basalt			
Drill hole OI-159. Coordinates, 10,500N, 14,495E. Elevation, 2,800 feet					
Qp	6.1	Soil and Palouse formation			
Tlu	7.3	Clay, transported, yellow, sandy micaceous	8.8	3.7	23.0
	9.1	Clay, transported, yellow; contains quartz, and mica			
	10.6	Clay, transported, pink, plastic	10.0	3.9	24.7
Tcl	12.6	Clay; residual from basalt; blue	9.5	35.9	18.2
		Basalt			

Drill hole logs and assay data of the Olson deposit—Continued

Formation	Depth (feet)	Description	Ignition loss	Availability Fe_2O_3	Availability Al_2O_3
Drill hole Ol-160. Coordinates, 10,995N, 12,490E. Elevation, 2,852 feet					
Qp	27.3	Soil and Palouse formation			
Tlu	37.3	Clay, transported, red, sandy	7.4	2.1	19.3
	39.4	do	4.4	2.3	10.7
	39.8	Limonite	5.0	8.1	12.1
	40.9	Clay, transported, red, sandy			
	41.2	Limonite			
	46.2	Clay, transported, gray and tan, plastic	11.2	10.7	28.4
	50.0	do	11.4	3.4	31.3
	50.3	Limonite			
	61.2	Clay, transported, gray, plastic	12.3	2.3	33.2
Tcl	66.2	Clay; residual from basalt; blue	11.6	2.1	31.9
	68.6	do	9.4	2.8	25.5
		Baslat			
Drill hole Ol-161. Coordinates, 10,995N, 13,495E. Elevation, 2,846 feet					
Qp	31.5	Soil and Palouse formation			
Tlu	32.6	Clay, transported, gray-yellow, sandy, micaceous	4.3	2.6	11.0
	38.5	Clay, transported, yellow, pink- and white-streaked	12.1	5.4	31.6
	42.3	Sand, transported, white and yellow, micaceous, slightly clayey.	4.7	1.6	11.1
	47.3	Clay, transported, gray, plastic, white- and brown-streaked.	11.9	1.8	32.4
	53.9	Clay, transported, pink, plastic, white-streaked			
Tcl	58.9	Clay; residual from basalt; yellow, blue-streaked	8.2	6.2	19.5
	64.9	Clay; residual from basalt; blue, yellow, and brown streaked.	7.1	8.1	13.7
		Basalt			
Drill hole Ol-162. Coordinates, 11,000N, 14,500E. Elevation, 2,806 feet					
Qp	9.0	Soil and Palouse formation			
Tlu	16.3	Clay, transported, pink, plastic	11.9	2.3	32.4
Tcl	19.3	Clay; residual from basalt; blue	9.0	5.0	23.4
		Basalt			
Drill hole Ol-163. Coordinates, 12,000N, 11,520E. Elevation, 2,822 feet					
Qp	18.7	Soil and Palouse formation			
Tcl	19.9	Clay; residual from basalt; blue	11.2	2.2	31.2
	21.0	Clay; residual from basalt; gray	9.4	2.1	25.3
	22.9	Clay; residual from basalt; blue	11.1	2.2	31.4
	27.0	Clay; residual from basalt; yellow-gray, pale yellow, to brown.	8.5	6.4	21.7
		Basalt			
Drill hole Ol-164. Coordinates, 11,490N, 13,000E. Elevation, 2,860 feet					
Qp	35.3	Soil and Palouse formation			
	36.5	Palouse formation: dark-brown, plastic clay; small muscovite flakes; beidellite in cracks.	5.0	6.1	11.0
	41.5	Palouse formation: dark-brown, plastic clay; small muscovite flakes.	3.9	5.3	8.6
Tlu	43.9	Clay, transported, light-gray, sandy, micaceous	6.3	2.6	16.1
	44.5	Clay, transported, yellow, limonite band	7.0	11.5	18.0
	46.7	Clay, transported, yellow, white-streaked; contains quartz grains.	10.2	7.9	26.3
	47.9	Limonite			
	51.7	Clay, transported, yellow; contains fine-grained muscovite and silt, gray and pink streaks.	11.4	14.0	27.6
	56.7	Clay, transported, pinkish-gray and tannish-gray; contains fine-grained muscovite and silt, plastic, gray-streaked, brown and black specks.	12.5	2.2	32.3
	61.4	Clay, transported, pinkish-gray and tannish-gray, fine-grained muscovite and silt, plastic, white-streaked.			
Tcl	65.7	Clay; residual from basalt; yellow- and blue-gray, olive-brown nontronite filling vesicles, speckled with white kaolinite filling pores.[8]	9.8	4.4	23.4
		Basalt			

[8] Gallium content, 0.004 percent.

Drill hole logs and assay data of the Olson deposit—Continued

Formation	Depth (feet)	Description	Ignition loss	Availability Fe_2O_3	Availability Al_2O_3
		Drill hole Ol-165. Coordinates, 11,490N, 13,500E. Elevation, 2,833 feet			
Qp	8.9	Soil and Palouse formation			
Tlu	13.9	Clay, transported, yellow, sandy, micaceous	9.2	5.8	23.6
	17.3	Clay, transported, yellow, pink- and white-streaked	12.3	4.5	33.3
	18.9	Clay, transported, yellow, very sandy	5.4	8.7	11.9
	30.5	Clay, transported, gray, plastic, white- and pink-streaked.	12.4	4.0	32.5
Tcl	35.8	Clay; residual from basalt; blue; yellow-streaked	9.2	7.6	20.8
		Basalt			
		Drill hole Ol-166. Coordinates, 11,490N, 14,000E. Elevation, 2,835 feet			
Qp	17.0	Soil and Palouse formation			
Tlu	25.9	Clay, transported, orange, sandy, micaceous	3.8	1.5	9.1
	26.1	Limonite	6.8	24.2	9.0
	36.7	Clay, transported, pink, plastic, white- and black-streaked.	11.8	3.2	29.3
Tcl	41.7	Clay; residual from basalt; blue	10.7	4.0	27.6
	43.2	do	8.9	5.5	20.7
		Basalt			
		Drill hole Ol-167. Coordinates, 11,480N, 11,500E. Elevation, 2,816 feet			
Qp	7.5	Soil and Palouse formation			
Tlu	11.0	Clay, transported, gray, sandy, micaceous	5.1	2.3	13.3
Tcl	11.5	Clay; residual from basalt; blue-gray	8.1	6.5	18.5
		Basalt			
		Drill hole Ol-168. Coordinates, 11,480N, 12,000E. Elevation, 2,831 feet			
Qp	11.0	Soil and Palouse formation			
Tlu	12.0	Clay, transported, yellow, plastic	9.6	10.8	23.0
	13.7	Clay, transported, yellow, sandy	4.0	3.4	9.6
	14.0	Limonite			
	15.4	Clay, transported, yellow, plastic	11.2	16.7	24.8
	25.9	Clay, transported, gray, plastic	12.9	2.3	33.0
	30.9	Clay, transported, white, sandy	7.7	1.0	20.6
Tcl	35.3	Clay; residual from basalt; blue	9.8	1.9	27.1
		Basalt			
		Drill hole Ol-169. Coordinates, 11,480N, 12,500E. Elevation, 2,859 feet			
Qp	31.0	Soil and Palouse formation			
Tlu	36.0	Clay, transported, red, sandy	4.5	2.3	11.0
	41.0	do	4.4	1.6	11.0
	44.5	do	9.4	2.9	25.0
	49.5	Clay, transported, white, sandy	7.2	1.8	18.9
	50.7	Limonite	10.2	21.7	20.4
	53.8	Clay, transported, yellow, plastic	8.5	9.6	19.8
	54.7	Clay, transported, white, sandy			
	65.4	Clay, transported, gray, plastic	11.9	2.6	31.3
Tcl	68.7	Clay; residual from basalt; blue	8.6	2.6	23.1
		Basalt			
		Drill hole Ol-170. Coordinates, 8,000N, 10,500E. Elevation, 2,808 feet			
Qp	2.0	Soil and Palouse formation			
Tlu	13.0	Limonite, hard			
Tcl	18.0	Clay; residual from basalt; brown	7.5	17.4	15.9
	23.0	Clay; residual from basalt; brown, blue-streaked	8.0	14.7	18.1
	25.7	do	7.8	15.3	15.0
		Basalt			

Drill hole logs and assay data of the Olson deposit—Continued

Formation	Depth (feet)	Description	Ignition loss	Availability Fe_2O_3	Availability Al_2O_3
Drill hole Ol–171. Coordinates, 7,485N, 10,495E. Elevation, 2,802 feet					
Qp	11.8	Soil and Palouse formation			
Tcl	21.8	Clay; residual from basalt; brown; yellow-streaked	10.4	21.5	27.1
	31.8	Clay; residual from basalt; yellow; brown- and black-streaked.	10.2	22.3	27.1
	36.8	do	10.2	21.0	25.1
	40.7	Clay; residual from basalt; blue; brown-streaked	9.7	17.4	23.6
		Basalt			
Drill hole Ol–172. Coordinates, 8,500N, 10,020E. Elevation, 2,856 feet					
Qp	15.0	Soil and Palouse formation: liminote			
Tlu	20.0	Clay, transported, yellow, sandy	3.6	10.1	6.0
	25.0	Clay, transported, yellow	7.6	8.5	18.0
	30.0	Clay, transported, yellow and pink	9.6	3.5	25.9
	35.0	Clay, transported, yellow			
	39.2	Clay, transported, yellow, sandy, thin dimonite band	9.4	7.7	22.8
	42.0	Clay, transported, yellow, plastic			
	50.5	Clay, transported, pinkish-gray, and gray, plastic	12.4	2.5	32.7
Tcl	55.5	Clay; residual from basalt; yellow, dark gray, and blue	9.5	14.3	22.0
	61.0	Clay; residual from basalt; blue and brown	8.8	14.6	19.4
		Basalt			
Drill hole Ol–173. Coordinates, 8,520N, 9,520E. Elevation, 2,803 feet					
Qp	7.5	Soil and Palouse formation: limonite			
Tcl	12.5	Clay; residual from basalt; gray, yellow- and white-streaked.	11.7	4.9	31.7
	17.5	do	11.7	1.3	32.7
	20.1	Clay; residual from basalt; blue	11.8	2.4	32.0
		Basalt			
Drill hole Ol–174. Coordinates, 11,490N, 14,500E. Elevation, 2,859 feet					
Qp	14.5	Soil and Palouse formation: limonite			
Tlu	16.5	Sand, transported, limonite cemented			
	18.5	Clay, transported, pink and yellow	7.6	9.6	18.3
	23.0	Clay, transported, yellow, pink-streaked	10.2	5.0	26.7
	23.6	Clay, transported, pink	9.9	3.8	26.2
	24.8	Clay, transported, yellow			
	27.6	Clay, transported, pink, yellow-streaked			
	30.7	Clay, transported, orange, sandy	3.6	2.6	8.4
	34.5	Clay, transported, yellow, sandy, micaceous	8.3	3.5	20.9
	39.5	Clay, transported, yellow	12.1	5.0	30.9
	46.8	do	12.2	4.5	32.1
	48.2	Clay, transported, pink, plastic	13.1	2.4	35.2
	49.2	Clay, transported, gray, plastic	6.2	1.3	15.9
	52.7	Clay, transported, gray, sandy			
	55.7	Clay, transported, yellow, sandy	4.7	1.8	11.2
	60.7	Clay, transported, green-gray, plastic, pink-streaked	12.6	2.2	33.8
	66.8	Clay, transported, pink-gray, plastic, white-streaked			
Tcl	71.3	Clay; residual from basalt; pale-green	10.1	7.7	24.3
		Basalt			
Drill hole Ol–175. Coordinates, 12,485N, 11,530E. Elevation, 2,805 feet					
Qp	6.0	Soil and Palouse formation			
Tcl	6.7	Clay; residual from basalt; bluish gray	6.5	6.5	18.2
		Basalt			
Drill hole Ol–176. Coordinates, 12,965N, 11,535E. Elevation, 2,811 feet					
Qp	5.2	Soil and Palouse formation			
Tcl		Basalt			

Drill hole logs and assay data of the Olson deposit—Continued

Formation	Depth (feet)	Description	Ignition loss	Availability Fe_2O_3	Availability Al_2O_3
		Drill hole Ol-177. Coordinates, 13,460N, 11,550E. Elevation, 2,848 feet			
Qp	10.7	Soil and Palouse formation			
Tlu	12.5	Clay, transported, pale-yellow	9.0	3.9	24.6
	17.0	Clay, transported, yellow and orange, sandy, micaceous.	5.1	3.3	13.7
	19.5	Clay, transported, yellow	7.8	5.5	20.9
	21.5	Clay, transported, yellow, sandy			
	22.3	Clay, transported, yellow	10.9	23.1	23.4
	23.2	Clay, transported, yellow; limonite bands			
	29.0	Clay, transported, pinkish-gray, plastic	12.0	3.1	32.5
Tcl	30.5	Clay, gray and blue; residual from basalt	11.1	1.1	31.9
	35.5	Clay, blue; residual from basalt	11.7	1.5	33.8
	41.7	Clay, green-blue; residual from basalt	10.1	5.5	28.1
		Basalt			
		Drill hole Ol-178. Coordinates, 12,000N, 12,530E. Elevation, 2,829 feet			
Qp	11.2	Soil and Palouse formation			
Tlu	12.6	Clay, transported, yellow, plastic	11.4	14.6	26.9
	12.9	Limonite			
	22.5	Clay, transported, gray, plastic	12.2	1.8	33.4
	24.0	Clay, transported, white sandy	9.1	1.8	25.2
Tcl	25.2	Clay; residual from basalt; gray-yellow	8.3	2.1	22.7
	26.4	Clay; residual from basalt; blue			
		Basalt			
		Drill hole Ol-179. Coordinates, 12,000N, 13,530E. Elevation, 2,858 feet			
Qp	10.8	Soil and Palouse formation			
Tlu	15.8	Clay, transported, gray-yellow, sandy	7.5	7.7	18.6
	20.8	do	10.5	5.8	28.1
	25.8	do	9.0	3.1	25.3
	30.8	do	9.4	3.5	25.7
	36.6	do	9.3	4.2	25.0
	39.3	Clay, transported, pink-yellow, sandy	11.1	4.8	29.5
	39.7	Clay, transported, yellow, plastic, speckled black			
	44.4	Clay, transported, yellow-white, sandy	5.1	2.6	12.1
	48.9	Clay, transported, pink-gray, plastic	13.0	3.1	32.8
	55.7	Clay, transported, black, plastic	19.2	1.8	29.2
	57.0	Clay, transported, white, sandy, micaceous	11.0	2.1	31.2
Tcl	60.0	Clay; residual from basalt; blue	9.8	1.0	30.0
		Basalt			
		Drill hole Ol-180. Coordinates, 12,000N, 14,500E. Elevation, 2,882 feet			
Qp	30.5	Soil and Palouse formation			
Tlu	32.0	Clay, transported, red-brown, coarse-grained sand and mica.	3.0	4.7	8.2
	36.0	Clay, transported, yellow, pink-stained	9.5	4.5	26.9
	44.1	Clay, transported, yellow-brown, micaceous, sandy	4.5	3.5	12.5
	49.1	Clay, transported, yellow and brown	9.9	3.1	28.6
	51.3	Clay, transported, yellow and gray	6.6	1.8	19.1
	56.2	Clay, transported, pale-yellow	10.0	2.3	28.6
	57.3	Clay, transported, brown, coarse-grained sand, micaceous.	3.5	3.1	9.2
	60.0	Clay, transported, yellow, sandy, micaceous, limonitic.			
	64.5	Clay, transported, light-gray, plastic	12.2	1.6	35.2
	66.0	Clay, transported, light-yellow, sandy	3.6	0.9	10.6
	69.9	Clay, transported, white, sandy			
	72.7	Clay, transported, brown, sandy	4.8	4.7	12.2
	73.0	Clay, transported, yellow, limonite			
	77.4	Clay, transported, yellow, sandy	4.0	2.0	10.5
	77.7	Clay, transported, limonite			
	87.9	Clay, transported, pink-gray, plastic	12.7	2.2	31.9
Tcl	92.4	Clay; residual from basalt; blue, green, and brown	10.1	7.0	24.2
	95.3	Clay; residual from basalt; yellow	8.1	12.5	16.3
		Basalt			

Drill hole logs and assay data of the Olson deposit—Continued

Formation	Depth (feet)	Description	Ignition loss	Availability Fe_2O_3	Availability Al_2O_3
Drill hole Ol-181. Coordinates, 11,995N, 15,500E. Elevation, 2,829 feet					
Qp	29.0	Soil and Palouse formation			
Tlu	39.2	Clay, transported, pink-gray, plastic, white-streaked	11.3	2.6	30.8
	42.4	Clay; residual from basalt; yellow and brown	7.2	18.2	14.5
		Basalt			
Drill hole Ol-182. Coordinates, 12,495N, 12,030E. Elevation, 2,834 feet					
Qp	21.7	Soil and Palouse formation			
Tlu	23.6	Clay, transported, dark-brown, plastic	5.0	4.7	12.1
Tcl	25.0	Clay; residual from basalt; gray	4.3	5.7	10.0
		Basalt			
Drill hole Ol-183. Coordinates, 12,510N, 12,540E. Elevation, 2,842 feet					
Qp	14.6	Soil and Palouse formation			
Tlu	17.3	Clay, transported, gray, plastic	10.0	2.0	27.0
	18.2	Clay, transported, red, sandy	4.9	4.7	11.4
	18.6	Clay, transported, yellow, plastic			
	19.3	Limonite	11.3	18.7	28.3
	20.3	Clay, transported, yellow, plastic			
	29.8	Clay, transported, gray, plastic	12.4	2.1	34.0
Tcl	34.8	Clay; residual from basalt; blue and yellow	8.9	4.1	23.6
	35.9	Clay; residual from basalt; blue and yellow	6.2	7.0	14.6
		Basalt			
Drill hole Ol-184. Coordinates, 12,510N, 13,070E. Elevation, 2,878 feet					
Qp	10.0	Soil and Palouse formation			
Tlu	15.0	Clay, transported, red, sandy	3.6	2.1	6.3
	18.9	do	5.2	2.1	14.3
	23.9	Clay, transported, pink-yellow, sandy	10.6	3.9	28.4
	28.9	do	8.3	3.1	22.8
	33.9	do	6.2	1.9	16.4
	38.9	do	7.2	1.9	19.3
	39.2	do	12.0	2.3	33.3
	41.3	Clay, transported, yellow-gray, plastic			
	46.3	Clay, transported, yellow-white, sandy	6.4	1.8	17.4
	48.4	do	4.5	2.6	11.4
	49.1	Limonite	7.7	20.9	13.5
	51.5	Clay, transported, yellow, plastic	11.9	13.5	27.9
	54.5	Clay, transported, gray-black-speckled, plastic	12.9	1.9	35.2
	55.5	Clay, transported, yellow, plastic	12.4	11.3	29.3
	63.4	Clay, transported, pink-gray, plastic, black-speckled	12.5	1.8	34.1
Tcl	68.4	Clay; residual from basalt; blue	9.7	6.1	26.0
	74.0	Clay; residual from basalt; blue, orange, streaked	9.1	9.5	23.8
		Basalt			
Drill hole Ol-185. Coordinates, 12,515N, 13,535E. Elevation, 2,872 feet					
Qp	9.2	Soil and Palouse formation			
Tlu	15.9	Clay, transported, red, sandy	3.6	2.6	9.7
	20.0	Clay, transported, white, sandy	10.0	1.6	29.7
	25.0	Clay, transported, red, sandy	2.4	4.8	5.4
	25.4	Clay, transported, pink, plastic	10.0	4.0	27.6
	29.2	Clay, transported, yellow-gray, plastic			
	32.0	Clay, transported, yellow, sandy	8.6	4.3	23.4
	32.9	Clay, transported, pink			
	35.1	Clay, transported, yellow, sandy	9.0	3.1	25.5
	39.1	Clay, transported, gray, sandy	8.5	1.9	24.7
	47.2	Clay, transported, yellow, sandy	6.0	3.2	16.3
	50.4	Clay, transported, pink-gray, plastic, back-speckled	11.6	3.7	32.7
	53.9	Clay, transported, yellow, sandy	4.6	4.2	12.2
	55.3	Clay, transported, pink-gray, sandy	9.1	3.9	25.6
	55.7	Limonite	9.8	10.0	25.1
	59.8	Clay, transported, yellow, sandy			
	75.7	Clay, transported, pink-gray, plastic	9.1	3.1	21.7
Tcl	80.4	Clay, blue; residual from basalt	9.4	3.7	23.7
		Basalt			

Drill hole logs and assay data of the Olson deposit—Continued

Formation	Depth (feet)	Description	Ignition loss	Availability Fe_2O_3	Availability Al_2O_3
Drill hole Ol-186. Coordinates, 12,530N, 14,000E. Elevation, 2,861 feet					
Qp	19.6	Soil and Palouse formation			
Tlu	23.0	Clay, transported, yellow-white, sandy	3.0	2.7	7.3
	24.7	Clay, transported, red, sandy	3.2	3.7	6.7
	33.5	Clay, transported, yellow, sandy	9.2	3.5	24.3
	36.3	Clay, transported, white, sandy	9.5	1.8	25.5
	38.7	Clay, transported, yellow, sandy	10.0	3.5	26.6
	43.3	Clay, transported, white, sandy	9.9	1.6	27.4
	48.3	Clay, transported, yellow and dark-brown, sandy	4.8	3.5	11.3
	54.3	Clay, transported, yellow, sandy	10.5	9.8	24.8
	65.4	Clay, transported, pink-gray, plastic	14.0	1.9	32.5
	67.5	Clay, transported, black, plastic	14.2	1.7	32.2
	68.5	Clay, transported, yellow-white, sandy, micaceous	12.1	4.1	31.4
Tcl	73.5	Clay, light-green; residual from basalt	8.6	8.8	20.9
	76.4	Clay, light-green; residual from basalt	7.6	8.7	16.7
		Basalt			
Drill hole Ol-187. Coordinates, 12,530N, 14,550E. Elevation, 2,853 feet					
Qp	11.0	Soil and Palouse formation			
Tlu	13.0	Clay, transported, yellow	9.6	4.3	25.4
	14.0	Clay, transported, pink			
	15.3	Clay, transported, orange, sandy	7.3	3.9	19.7
	16.7	Clay, transported, yellow			
	18.0	Clay, transported, yellow and gray, plastic	7.0	2.6	19.2
	18.8	Clay, transported, yellow and brown, sandy			
	23.0	Clay, transported, yellow, sandy micaceous	7.6	2.4	21.4
	27.7	Clay, transported, yellow	10.2	3.4	27.4
	31.0	Clay, transported, pale-yellow, pink-streaked	6.9	1.6	19.6
	31.3	Limonite			
	32.5	Clay, transported, yellow	6.6	3.2	17.1
	33.0	Clay, transported, brown, sandy, limonite			
	34.2	Clay, transported, light-gray, sandy	3.6	1.4	9.8
	36.6	Clay, transported, yellow, sandy, micaceous			
	39.8	Clay, transported, light-gray and pink, plastic	10.9	2.1	30.0
	41.5	Clay, transported, yellow, sandy			
	42.2	Sand, transported, limonite cemented	4.0	6.9	8.9
	43.5	Clay, transported, yellow, sandy	4.1	6.9	9.3
	44.2	Limonite			
	44.6	Clay, transported, pink			
	46.0	Clay, transported, yellow, plastic	10.8	11.9	27.1
	46.4	Limonite			
	47.7	Clay, transported, orange			
	52.7	Clay, transported, gray, plastic	12.6	2.1	32.7
	56.4	Clay, transported, pink-gray, plastic			
Tcl	58.0	Clay; residual from basalt; pale-yellow	9.8	9.0	24.2
	61.2	Clay; residual from basalt; green-gray	9.5	7.5	23.0
		Basalt			
Drill hole Ol-188. Coordinates, 12,980N, 12,540E. Elevation, 2,857 feet					
Qp	31.7	Soil and Palouse formation			
Tlu	32.0	Clay, transported, red, sandy	8.7	13.5	19.7
	32.3	Limonite			
	34.7	Clay, transported, yellow-gray, plastic	11.7	4.8	30.7
	43.5	Clay, transported, gray, plastic	12.0	1.9	32.9
Tcl	45.9	Clay; residual from basalt; gray	8.4	3.6	23.4
	50.0	Clay; residual from basalt; yellow	8.5	14.7	20.5
	51.3	Clay; residual from basalt; blue	9.2	11.0	22.9
		Basalt			
Drill hole Ol-189. Coordinates, 13,000N, 13,505E. Elevation, 2,862 feet					
Qp	4.2	Soil and Palouse formation			
Tlu	13.0	Clay, transported, red, sandy	4.0	3.9	8.7
	15.2	Limonite	2.8	9.2	3.8
	17.5	Clay, transported, red, sandy	3.7	6.9	7.5
	22.5	Clay, transported, white, red; sandy streaks	6.7	1.9	17.3
	29.7	Clay, transported, white, red; sandy streaks	5.7	2.9	14.1
	33.6	Clay, transported, yellow, plastic	10.7	3.7	27.3
	36.8	Clay, transported, gray, plastic	12.2	2.1	31.5

Drill hole logs and assay data of the Olson deposit—Continued

Formation	Depth (feet)	Description	Ignition loss	Availability Fe_2O_3	Availability Al_2O_3
		Drill hole Ol-189—Continued			
Tlu	37.9	Clay, transported, white, sandy	4.1	1.9	10.1
	40.9	Clay, transported, gray, plastic	8.7	1.9	22.6
	41.5	Clay, transported, white, sandy			
	44.9	Clay, transported, yellow, plastic	11.3	19.2	23.5
	55.8	Clay, transported, pink-gray, plastic, white-streaked	14.8	1.9	31.8
Tcl	61.9	Clay; residual from basalt; blue	9.9	4.3	25.6
		Basalt			
		Drill hole Ol-190. Coordinates, 13,005N, 14,500E. Elevation, 2,834 feet			
Qp	21.5	Soil and Palouse formation			
Tlu	22.5	Clay, transported, brown, sandy, limonite	5.9	10.2	11.4
	25.8	Clay, transported, orange	10.6	13.6	23.4
	37.3	Clay, transported, pink-gray, plastic; pale-yellow streaks.	12.2	2.6	31.0
Tcl	38.4	Clay; residual from basalt; yellow-gray	12.0	1.6	32.6
	39.0	Clay; residual from basalt; blue-gray	11.5	3.3	29.7
	42.3	Clay; residual from basalt; green-gray	8.8	8.0	21.0
	43.7	Clay; residual from basalt; yellow-brown	6.6	11.0	14.6
		Basalt			
		Drill hole Ol-191. Coordinates, 13,475N, 12,055E. Elevation, 2,830 feet			
Qp	9.9	Soil and Palouse formation			
Tcl	19.9	Clay; residual from basalt; yellow	8.5	16.0	17.9
	26.2	do	7.3	17.9	13.8
		Basalt			
		Drill hole Ol-192. Coordinates, 13,490N, 12,565E. Elevation, 2,842 feet			
Qp	24.5	Soil and Palouse formation			
Tlu	29.2	Clay, transported, pink-gray, plastic, white-streaked	11.4	2.4	30.4
Tcl	30.8	Clay; residual from basalt; yellow-gray	11.5	2.6	31.9
	33.5	Clay; residual from basalt; brown-yellow	11.2	6.8	31.3
	43.5	Clay; residual from basalt; yellow-gray, and blue	11.9	2.3	33.3
	45.2	Clay; residual from basalt; green-blue	10.2	8.3	29.6
		Basalt			
		Drill hole Ol-193. Coordinates, 13,500N, 13,000E. Elevation, 2,848 feet			
Qp	12.7	Soil and Palouse formation			
Tlu	14.2	Clay, transported, red-brown and yellow; contains fine-grained quartz, and muscovite; mottled white.	8.9	5.4	23.9
	16.1	do	8.5	4.0	23.0
	18.6	do	5.4	4.2	14.2
	21.0	Clay, transported, brown-yellow; contains fine-grained quartz and muscovite; mottled white with kaolinite; limonite bands.	9.1	3.8	24.3
	22.0	Clay, transported, yellow; contains quartz and muscovite grains and limonite bands.	6.2	6.2	15.7
	24.2	Clay, transported, gray, yellow, and brown; contains sandy layers; muscovitic.	7.6	2.6	21.0
	25.5	Clay, transported, gray; contains a small amount of quartz and muscovite grains.	10.0	1.9	28.3
	26.5	Clay, transported, yellow-brown, sandy	8.3	1.9	22.9
	28.7	Clay, transported, gray, fine-grained sand			
	29.7	Clay, transported, red-brown, sandy, slightly muscovitic.	5.0	2.6	13.4
	31.2	Clay, transported, yellow-gray; contains fine-grained quartz and muscovite.	9.2	2.4	25.8
	32.2	Clay, transported, red-brown, sandy; contains fine-grained muscovite and limonite bands.	6.6	3.7	17.7
	33.4	Clay, transported, yellow; contains a little fine-grained quartz and muscovite.	10.9	23.3	24.2
	34.9	Clay, transported, yellow and gray; limonite			
	36.2	Clay, transported, pinkish gray; contains fine-grained quartz and muscovite.	12.4	5.3	32.5

Drill hole logs and assay data of the Olson deposit—Continued

Formation	Depth (feet)	Description	Ignition loss	Availability Fe_2O_3	Availability Al_2O_3
		Drill Hole Ol-193—Continued			
Tlu	43.7	Clay, transported, pinkish gray; contains fine-grained quartz and muscovite, plastic, white-streaked.	12.5	1.9	34.1
	45.6	Clay, transported, tan and gray; contains fine-grained sand and muscovite.	8.8	1.6	24.8
Tcl	51.4	Clay; residual from basalt; blue-gray; olive-green nontronite fills vesicles.[9]	9.2	8.5	25.3
		Basalt			

[9] Gallium content, 0.004 percent.

		Drill hole Ol-194. Coordinates, 12,540N, 15,000E. Elevation, 2,854 feet			
Qp	13.0	Soil and Palouse formation			
Tlu	14.0	Clay, transported, yellow	3.2	2.1	7.3
	18.0	Clay, transported, orange and yellow, very sandy			
	18.5	Clay, transported, yellow	8.3	1.8	23.7
	19.5	Clay, transported, pale-yellow and gray			
	21.1	Clay, transported, yellow, sandy	6.8	3.0	19.1
	22.8	Clay, transported, yellow, plastic			
	24.8	Clay, transported, yellow, sandy, thin plastic bands	6.1	2.0	16.1
	26.6	Clay, transported, yellow, plastic	11.3	3.4	30.5
	28.4	Clay, transported, violet-gray and yellow	11.1	3.5	30.3
	30.8	Clay, transported, pink-yellow	8.3	2.1	23.0
	33.0	Clay, transported, yellow, sandy	4.6	1.9	11.9
	33.8	Sand, transported, yellow; and green clay	6.4	5.3	15.9
	34.4	Limonite			
	37.8	Clay, transported, gray, plastic	11.7	1.8	33.4
	42.2	Clay, transported, white, sandy	3.9	0.8	10.6
	42.7	Clay, transported, yellow and brown, sandy	4.4	1.4	11.9
	43.4	Clay, transported, light-gray, sandy			
	45.7	Clay, transported, pink	3.3	1.3	8.4
	46.4	Clay, transported, reddish-brown, sandy			
	47.6	Limonite	6.5	19.8	10.1
	57.2	Clay, transported, pink, plastic	11.9	2.9	32.2
Tcl	57.7	Clay; residual from basalt; gray	9.9	2.3	28.5
	59.7	Clay; residual from basalt; blue	9.2	2.9	24.9
		Basalt			

		Drill hole Ol-195. Coordinates, 12,540N, 15,540E. Elevation, 2,823 feet			
Qp	18.0	Soil and Palouse formation			
Tlu	23.0	Clay, transported, pink-gray, plastic	10.3	5.6	26.2
	28.3	——do——	12.7	1.9	33.7
Tcl	29.0	Clay; residual from basalt; gray	10.7	6.2	25.5
		Basalt			

		Drill hole Ol-196. Coordinates, 13,020N, 15,505E. Elevation, 2,856 feet			
Qp	6.5	Soil and Palouse formation			
Tlu	7.3	Sand, transported, limonite cemented			
	9.5	Clay, transported, white and yellow, sandy	5.0	1.6	12.6
	14.0	Clay, transported, red, very sandy, micaceous	3.4	1.7	7.3
	18.0	Clay, transported, yellow and gray, plastic	10.6	5.0	28.6
	21.8	Clay, transported, light-yellow, slightly micaceous, pink-stained.	9.4	5.0	27.5
	22.5	Clay, transported, gray, plastic, pink-streaked	9.8	2.4	26.9
	25.8	Clay, transported, gray, sandy, micaceous	6.5	1.7	18.9
	27.6	Clay, transported, gray and yellow	9.4	2.3	30.6
	29.7	Clay, transported, gray, sandy	7.4	2.0	23.4
	34.7	Clay, transported, yellow, slightly sandy and micaceous.	10.0	3.3	25.5
	37.0	Clay, transported, yellow			
	39.7	Clay, transported, white and yellow, sandy, micaceous	4.8	1.3	14.1
	43.0	Clay, transported, yellow	9.0	7.4	24.3
	45.2	Clay, transported, yellow, plastic	11.5	14.3	26.5
	47.3	Clay, transported, gray, sandy, micaceous	8.4	1.6	22.0
	59.2	Clay, transported, gray, plastic, pink-streaked	11.2	2.0	32.6
Tcl	64.2	Clay; residual from basalt; blue and yellow	8.0	12.5	17.3
	66.4	Clay; residual from basalt; blue	5.9	16.4	15.0
		Basalt			

Drill hole logs and assay data of the Olson deposit—Continued

Formation	Depth (feet)	Description	Ignition loss	Availability Fe_2O_3	Availability Al_2O_3
		Drill hole Ol-197. Coordinates, 13,500N, 13,500E. Elevation, 2,803 feet			
Qp	6.0	Soil and Palouse formation			
Tcl	8.5	Clay; residual from basalt; gray and brown	9.1	16.3	22.3
		Basalt			
		Drill hole Ol-198. Coordinates, 13,500N, 14,000E. Elevation, 2,820 feet			
Qp	14.5	Soil and Palouse formation			
Tlu	21.3	Clay, transported, pink-gray, plastic	11.2	3.4	30.2
Tcl	22.6	Clay; residual from basalt; yellow-gray	9.2	6.8	23.3
	24.0	Clay; residual from basalt; blue	8.1	5.5	21.0
		Basalt			
		Drill hole Ol-199. Coordinates, 13,500N, 14,500E. Elevation, 2,820 feet			
Qp	15.2	Soil and Palouse formation			
Tlu	22.5	Clay, transported, pink-gray, plastic	11.4	2.3	31.3
Tcl	23.3	Clay; residual from basalt; brown and yellow	8.5	10.1	21.1
	25.9	Clay; residual from basalt; blue	9.1	4.8	23.2
		Basalt			
		Drill hole Ol-200. Coordinates, 13,500N, 15,000E. Elevation, 2,868 feet			
Qp	6.0	Soil and Palouse formation			
Tlu	9.0	Clay, transported, yellow-brown, sandy	5.2	5.8	11.2
	9.7	Clay, transported, pale-yellow	5.6	2.6	14.1
	11.2	Clay, transported, yellow, sandy			
	11.4	Sand, transported, limonite-cemented	5.4	8.6	11.1
	19.7	Clay, transported, red-brown, sandy, micaceous	3.8	3.7	8.1
	27.8	Clay, transported, yellow	9.4	4.5	23.7
	29.4	Clay, transported, pink-yellow, sandy			
	33.8	Clay, transported, pink; contains abundant quartz grains.	3.6	1.1	8.9
	34.9	Clay, transported, yellow, sandy			
	42.0	Clay, transported, pale-yellow, plastic	9.9	3.4	25.8
	43.5	Clay, transported, yellow, sandy	4.0	1.8	9.1
	44.4	Clay, transported, yellow and red-brown plastic	11.4	1.9	30.4
	46.4	Clay, transported, gray, plastic			
	51.4	Clay, transported, gray, sandy	3.7	1.4	8.5
	54.0	Clay, transported, brown-yellow, sandy			
	56.0	Limonite			
	56.5	Clay, transported, yellow	9.1	25.4	14.8
	57.0	Clay, transported, limonite			
	63.8	Clay, transported, pinkish-gray, plastic, white-streaked.	12.5	2.4	32.1
Tcl	66.4	Clay; residual from basalt; blue	10.4	4.3	26.5
	67.4	Clay; residual from basalt; yellow, brown, and blue	7.8	8.9	14.9
		Basalt			
		Drill hole Ol-201. Coordinates, 13,450N, 11,050E. Elevation, 2,849 feet			
Qp	4.3	Soil and Palouse formation			
Tlu	8.0	Clay, transported, yellow-brown, sandy, micaceous	6.2	3.5	16.9
	8.5	Clay, transported, pink	8.9	4.7	24.5
	9.0	Clay, transported, yellow-brown			
	11.4	Clay, transported, pale-yellow	9.2	2.3	26.1
	14.0	Clay, transported, yellow and gray	11.0	7.6	29.2
	15.2	Clay, transported, orange, limonitic	11.4	24.4	24.6
	17.3	Clay, transported, yellow and gray, plastic	12.0	8.0	31.2
	24.5	Clay, transported, pink-gray, plastic	12.2	2.3	33.1
Tcl	25.8	Clay; residual from basalt; gray	10.6	1.9	30.7
	29.8	Clay; residual from basalt; blue	10.0	1.4	29.4
		Basalt			

Drill hole logs and assay data of the Olson deposit—Continued

Formation	Depth (feet)	Description	Ignition loss	Availability Fe_2O_3	Availability Al_2O_3
		Drill hole Ol-202. Coordinates, 10,980N, 11,490E. Elevation, 2,835 feet			
Qp	9.0	Soil and Palouse formation			
Tlu	10.0	Clay, transported, yellow	4.1	6.0	8.4
	11.5	Clay, transported, gray and yellow, sandy	4.3	3.3	11.1
	12.5	Clay, transported, yellow, sandy, limonitic	5.7	7.7	14.0
	15.4	Clay, transported, orange	11.2	14.8	25.7
	20.4	Clay, transported, pinkish-gray and gray, plastic, white-streaked.	12.3	2.2	32.9
	22.5	Clay, transported, pinkish-gray, plastic			
Tcl	28.2	Clay; residual from basalt; yellow-brown	6.5	9.6	15.8
		Basalt			
		Drill hole Ol-203. Coordinates, 14,475N, 7,550E. Elevation, 2,843 feet			
Qp	13.8	Soil and Palouse formation			
Tlu	23.5	Clay, transported, yellow-white, sandy, micaceous	6.4	2.2	17.8
	28.5	Clay, transported, pink-gray, plastic	10.9	2.1	26.8
	33.5	do	9.3	2.0	20.9
	38.5	do	8.0	1.7	28.3
	45.5	do	10.6	1.5	33.0
	48.2	Clay, transported, yellow, white-streaked	10.4	8.8	27.3
	53.2	Clay, transported, yellow-white, sandy, micaceous	5.4	1.6	15.5
	58.2	Clay, transported, white, sandy, micaceous			
	63.2	do	6.1	1.4	17.7
	73.2	do	4.8	1.2	13.8
	78.2	Clay, transported, yellow; streaked by white sandy micaceous clay.	7.0	1.7	19.7
	83.2	Clay, transported, yellow, sandy, micaceous	5.8	6.7	15.5
	85.6	Clay, transported, white, sandy, micaceous	7.4	1.3	19.8
	88.0	Clay, transported, black, plastic	17.8	1.3	24.4
	90.5	Clay, transported, pink-gray, plastic	13.7	1.3	25.5
	90.8	Clay, transported, black, plastic			
Tcl	93.7	Clay; residual from basalt; blue	9.6	4.1	25.2
		Basalt, blue; incompletely weathered			
		Drill hole Ol-204. Coordinates, 14,475N, 8,550E. Elevation, 2,876 feet			
Qp	17.9	Soil and Palouse formation			
Tlu	22.9	Clay, transported, gray, sandy	10.5	2.1	30.0
	27.9	Clay, transported, yellow-gray, sandy, micaceous	8.9	1.3	25.8
	32.9	Clay, transported, pink-yellow, sandy, micaceous	7.4	1.3	21.6
	34.0	Sand, transported, limonite-cemented	6.9	3.6	19.8
		Drill hole Ol-204. Coordinates, 14,420N, 8,550E. Elevation, 2,862 feet			
Qp	16.0	Soil and Palouse formation			
Tlu	21.0	Clay, transported, yellow-gray, plastic	10.4	6.6	29.0
	38.0	Clay, transported, gray, plastic	11.2	1.5	32.0
	43.9	Clay, transported, white, sandy	7.4	1.0	22.5
	45.0	Clay, transported; heavily stained with limonite	6.5	15.2	15.0
	50.0	Clay, transported, yellow-white, sandy	6.4	7.8	16.9
	55.0	Clay, transported, white, sandy	7.0	2.8	20.9
	80.0	Clay, transported, yellow-white, sandy	7.2	2.9	20.5
KJg	85.0	Clay; residual from granodiorite; yellow; sandy	6.5	4.6	17.4
	95.0	do	6.4	4.8	16.7
	105.0	do	5.8	4.8	15.4
	115.0	Clay; residual from granodiorite; yellow-brown; sandy	5.8	5.1	13.8
	125.0	Clay; residual from granodiorite; yellow and white-streaked; sandy.	5.8	5.6	14.9
	135.0	Clay; residual from granodiorite; yellow-brown; sandy	6.2	4.7	16.4
	139.0	Clay; residual from granodiorite; yellow-brown; sandy; white-streaked.	6.0	4.7	15.4
	142.4	Clay; residual from granodiorite; yellow-brown; streaked with pink plastic clay.	5.5	4.3	15.3

Drill hole logs and assay data of the Olson deposit—Continued

Formation	Depth (feet)	Description	Ignition loss	Availability Fe_2O_3	Availability Al_2O_3
		Drill hole Ol-205. Coordinates, 13,500N, 15,495E. Elevation, 2,839 feet			
Qp	18.0	Soil and Palouse formation			
	22.5	Clay, transported, yellow, sandy; contains thin limonite bands.	9.9	10.5	24.5
	25.2	Clay, transported, yellow, gray-streaked			
	30.2	Clay, transported, dark-brown, plastic	12.3	1.7	34.0
Tcl	35.2	Clay; residual from basalt; blue	10.5	6.4	28.4
	37.6	Clay; residual from basalt; yellow and brown	7.8	13.3	17.2
		Basalt			
		Drill hole Ol-206. Coordinates, 14,455N, 9,060E. Elevation 2,829 feet			
Qp	9.4	Soil and Palouse formation			
Tlu	14.4	Clay, transported, yellow	8.4	17.5	18.5
	15.0	do	10.9	2.2	31.6
	20.0	Clay, transported, light-gray, blue-streaked			
	28.0	do	10.7	1.1	32.0
	38.0	Clay, transported, light-gray, plastic	10.5	1.2	30.4
	48.0	do	9.3	1.1	27.0
	53.0	Clay, transported, light-yellow, slightly micaceous	7.8	1.4	22.6
KJg	63.0	Clay; residual from granodiorite; yellow; sandy; micaceous.	7.0	4.1	19.2
	68.0	Clay; residual from granodiorite; yellow; sandy; micaceous.	6.6	2.9	18.2
	73.0	Clay; residual from granodiorite; yellow; sandy; micaceous; white-streaked.			
	83.0	Clay; residual from granodiorite; white; sandy; micaceous.	6.2	1.1	17.8
	93.0	Clay; residual from granodiorite; gray; sandy; contains coarse mica books.	6.7	1.3	19.4
	98.0	Clay; residual granodiorite; yellow; sandy; micaceous	6.4	3.3	17.8
	108.0	Clay; residual from granodiorite; light-gray; sandy; contains mica books and granite pebbles.	6.4	1.6	18.4
	113.0	do	6.2	1.7	17.9
	114.2	Clay; residual from granodiorite; yellow			
		Granodiorite			
		Drill hole Ol-207. Coordinates, 14,450N, 9,560E. Elevation, 2,824 feet			
Qp	10.5	Soil and Palouse formation			
Tcl	15.5	Clay; residual from basalt; blue; yellow- and brown-streaked.	9.6	9.8	27.1
	23.0	Clay; residual from basalt; blue	10.7	5.6	30.9
	28.0	Clay; residual from basalt; yellow	10.6	5.7	29.0
	35.8	Clay; residual from basalt; blue	11.2	6.5	30.1
	37.8	Clay; residual from basalt; yellow and blue	10.3	11.3	25.9
		Basalt			
		Drill hole Ol-208. Coordinates, 14,450N, 10,055E. Elevation, 2,826 feet			
Qp	10.1	Soil and Palouse formation			
Tcl	15.0	Clay; residual from basalt; blue	6.2	5.3	18.4
		Basalt			
		Drill hole Ol-209. Coordinates, 13,515N, 7,575E. Elevation, 2,821 feet			
Qp	10.5	Soil and Palouse formation			
Tlu	15.5	Clay, transported, pink-gray	8.4	3.1	22.9
	25.5	do	7.6	1.8	19.6
	30.5	Clay, transported, pink-gray, plastic	10.9	0.9	30.1
	35.2	Clay, transported, gray and white			
	37.0	Clay, transported, brown-yellow	9.9	10.3	23.7
	39.5	Clay, transported, gray, sandy	4.2	1.4	11.1
	40.3	Clay, transported, brownish-yellow	9.6	6.8	24.9
	46.6	Clay, transported, gray, sandy	2.6	0.9	7.4
	48.2	Clay, transported, yellow and brown	8.0	4.2	22.1
	53.7	Clay, transported, brown-yellow and gray, sandy	3.1	3.2	7.6

Drill hole logs and assay data of the Olson deposit—Continued

Formation	Depth (feet)	Description	Ignition loss	Availability Fe_2O_3	Availability Al_2O_3
		Drill hole Ol-209—Continued			
Tlu	57.4	Clay, transported, yellow	5.9	3.4	15.9
	58.0	Limonite			
	63.0	Clay, transported, gray, yellow, and brown	5.1	3.5	13.9
	63.5	Clay, transported, gray, and yellow, sandy			
	64.6	Clay, transported, gray	6.2	1.4	17.0
	66.6	Clay, transported, brown, sandy, micaceous	2.4	2.2	7.0
	71.6	Clay, transported, light-gray	5.7	0.9	16.3
	75.4	Clay, transported, brown and gray	5.2	2.2	15.1
	76.6	Clay, transported, brown, limonite	8.6	18.3	19.9
	80.0	Clay, transported, yellow-brown and gray	7.1	7.9	17.8
	84.6	Clay, transported, black	14.0	2.6	24.8
Tcl		Basalt			
		Drill hole Ol-210. Coordinates, 13,465N, 10,535E. Elevation, 2,825 feet			
Qp	13.5	Soil and Palouse formation			
Tcl	15.0	Clay; residual from basalt; blue	10.4	4.8	28.1
	17.6	Clay; residual from basalt; gray, brown, and yellow	8.3	10.8	18.0
		Basalt			
		Drill hole Ol-211. Coordinates, 13,960N, 10,535E. Elevation, 2,834 feet			
Qp	12.4	Soil and Palouse formation			
Tcl	17.4	Clay; residual from basalt; yellow	7.6	16.3	16.5
	20.7	Clay; residual from basalt; brown and yellow			
		Basalt			
		Drill hole Ol-212. Coordinates, 13,950N, 11,550E. Elevation, 2,864 feet			
Qp	33.0	Soil and Palouse formation			
Tlu	37.6	Clay, transported, brownish-yellow	10.1	9.4	25.3
	48.1	Clay, transported, gray and pink, plastic	12.5	1.6	34.1
Tcl	50.7	Clay; residual from basalt; light gray	9.8	0.7	28.1
	53.5	Clay; residual from basalt; blue	11.5	1.4	33.1
	57.2	Clay; residual from basalt; blue-gray	10.2	5.2	28.2
		Basalt			
		Drill hole Ol-213. Coordinates, 14,440N, 10,540E. Elevation, 2,839 feet			
Qp	24.8	Soil and Palouse formation			
Tcl	27.1	Clay; residual from basalt; yellow and blue	7.8	11.9	19.7
		Basalt			
		Drill hole Ol-214. Coordinates, 13,960N, 12,580E. Elevation, 2,807 feet			
Qp	10.5	Soil and Palouse formation			
Tcl	12.0	Clay; residual from basalt; blue and brown	6.9	8.6	18.7
		Basalt			
		Drill hole Ol-215. Coordinates, 14,445N, 11,070E. Elevation, 2,803 feet			
Qp	3.5	Soil and Palouse formation			
Tc		Basalt			
		Drill hole Ol-217. Coordinates, 17,840N, 12,140E. Elevation, 2,840 feet			
Qp	11.1	Soil and Palouse formation			
Tc		Basalt			

Drill hole logs and assay data of the Olson deposit—Continued

Formation	Depth (feet)	Description	Ignition loss	Availability Fe_2O_3	Availability Al_2O_3
		Drill hole Ol-219. Coordinates, 17,805N, 13,125E. Elevation, 2,842 feet			
Qp	10.0	Soil and Palouse formation			
Tlu	15.0	Clay, transported, yellow-gray	7.0	3.2	17.8
	17.0	Clay, transported, yellow-brown, micaceous, sandy	4.6	6.1	10.9
	17.5	Limonite	6.2	22.2	11.0
Tcl	22.0	Clay; residual from basalt; blue	10.8	4.7	30.7
		Basalt			
		Drill hole Ol-221. Coordinates, 17,760N, 14,125E. Elevation, 2,833 feet			
Qp	10.6	Soil and Palouse formation			
Tc		Basalt			
		Drill hole Ol-222. Coordinates, 17,730N, 15,125E. Elevation, 2,807 feet			
Qp	24.0	Soil and Palouse formation			
Tcl		Basalt			
		Drill hole Ol-223. Coordinates, 16,835N, 12,125E. Elevation, 2,825 feet			
Qp	6.9	Soil and Palouse formation			
Tc		Basalt			
		Drill hole Ol-224. Coordinates, 16,785N, 13,125E. Elevation, 2,817 feet			
Qp	5.3	Soil and Palouse formation			
Tc		Basalt			
		Drill hole Ol-225. Coordinates, 16,730N, 14,124E. Elevations, 2,819 feet			
Qp	9.9	Soil and Palouse formation			
Tcl	14.9	Clay; residual from basalt; blue	9.0	11.7	22.9
	22.8	----do	8.8	11.5	24.0
		Basalt			
		Drill hole Ol-226. Coordinates, 16,685N, 15,100E. Elevation, 2,759 feet			
Qp	9.5	Soil and Palouse formation			
Tll	10.7	Clay, transported, yellow sandy	8.5	8.7	22.7
	14.7	Clay, transported, yellow, sandy	9.2	13.7	22.7
	17.3	Limonite	4.8	17.5	7.9
	26.0	Clay, transported, yellow, sandy, white-streaked	8.3	5.3	22.1
	28.3	Clay, transporred, red, sandy	4.6	6.4	10.6
	32.5	Clay, transported, white, sandy	2.3	2.6	5.8
	32.9	Clay, transported, white, sandy, orange-streaked	2.8	2.3	7.1
	33.5	Clay, transported, yellow, sandy			
	34.1	Clay, transported, orange, sandy			
	39.1	Clzy, transported, gray, sandy	7.4	2.3	20.3
	41.2	Clay, transported, orange and yellow, sandy	2.9	2.8	7.0
	41.8	Limonite	4.0	16.4	6.6
	43.5	Clay, transported, gray, and yellow, sandy	6.5	5.9	16.5
	46.2	Clay, transported, orange, sandy	3.8	5.3	8.5
	49.4	Clay, transported, yellow, sandy	8.0	13.3	18.5
	52.3	----do	15.2	8.9	23.1
		Drill hole Ol-228. Coordinates, 19,885N, 12,165E. Elevation, 2,767 feet			
Qp	10.5	Soil and Palouse formation			
Tc	16.0	Basalt			

Drill hole logs and assay data of the Olson deposit—Continued

Formation	Depth (feet)	Description	Ignition loss	Availability Fe_2O_3	Availability Al_2O_3
		Drill hole OI-229. Coordinates, 19,870N, 13,170E. Elevation, 2,780 feet			
Qp	9.5	Soil and Palouse formation			
Tlu	13.0	Clay, transported, yellow-brown	9.9	21.6	22.6
	14.4	Clay, transported, pinkish-yellow	10.2	12.3	24.1
	16.9	Clay, transported, pinkish-gray, plastic	10.0	3.8	26.0
Tcl	20.5	Clay; residual from basalt; yellow	12.0	3.3	32.4
	22.5	Clay; residual from basalt; yellow-brown	8.8	17.5	21.4
		Basalt			
		Drill hole OI-230. Coordinates, 19,845N, 14,175E. Elevation, 2,737 feet			
Qp	2.0	Soil and Palouse formation			
Tc		Basalt			
		Drill hole OI-231. Coordinates, 14,450N, 11,575E. Elevation, 2,835 feet			
Qp	16.3	Soil and Palouse formation			
Tcl	19.3	Clay; residual from basalt; blue and gray	8.3	13.2	20.1
		Basalt			
		Drill hole OI-232. Coordinates, 18,880N, 12,165E. Elevation, 2,852 feet			
Qp	15.5	Soil and Palouse formation			
Tcl	19.9	Clay; residual from basalt; blue	11.4	5.6	28.4
	21.6	Clay; residual from basalt; pale-yellow	9.9	4.8	25.4
	26.6	Clay; residual from basalt; brown	8.8	17.1	21.3
	29.3	Clay; residual from basalt; blue	7.2	5.1	21.2
		Basalt			
		Drill hole OI-233. Coordinates, 18,865N, 13,140E. Elevation, 2,744 feet			
Qp	6.0	Soil and Palouse formation			
Tcl	8.0	Clay; residual from basalt, blue	9.0	5.1	21.2
		Basalt			
		Drill hole OI-234. Coordinates 18,845N, 14,160E, Elevation, 2,739 feet			
Qp	15.8	Soil and Palouse formation			
Tlu	17.3	Clay, transported, black, micaceous	8.0	2.7	19.3
	18.5	Clay, transported, brown, sandy	5.4	3.0	13.3
Tcl	28.5	Clay; residual from basalt; blue	9.5	2.4	24.4
	30.1	----do	6.6	4.2	15.0
		Basalt			
		Drill hole OI-235. Coordinates, 18,825N, 15,160E. Elevation, 2,740 feet			
Qp	27.6	Soil and Palouse formation			
Tcl	32.6	Clay; residual from basalt; blue	10.8	2.2	27.6
	42.6	Clay; residual from basalt; dark-gray; brown-streaked			
	44.5	Clay; residual from basalt; blue; contains limonite bands.	9.5	4.2	23.4
	52.2	Clay; residual from basalt; blue	6.3	3.7	15.2
		Basalt			
		Drill hole OI-236. Coordinates, 14,400N, 12,070E. Elevation, 2,822 feet			
Qp	9.8	Soil and Palouse formation			
Tc		Basalt			

Drill hole logs and assay data of the Olson deposit—Continued

Formation	Depth (feet)	Description	Ignition loss	Availability Fe_2O_3	Availability Al_2O_3
Drill hole Ol-238. Coordinates, 19,855N, 13,715E. Elevation 2,804 feet					
Qp	7.8	Soil and Palouse formffition			
Tlu	10.7	Clay, transported, gray	6.0	3.2	17.7
	11.5	Limonite	3.5	10.1	4.6
	16.5	Clay, transported, orange, sandy			
	21.1	Sand, transported, coarse-grained, micaceous	1.4	3.8	3.6
	22.8	Clay, transported, gray, plastic	7.6	5.1	20.6
	24.0	Clay, transported, yellow, sandy, limonitic			
	26.1	Clay, transported, yellow, plastic	6.9	9.3	17.7
	27.0	Clay, transported, yellow-brown			
	28.2	Clay, transported, gray, plastic	8.9	4.0	25.2
Tcl	29.6	Clay; residual from basalt; blue-gray	10.5	6.5	28.0
		Basalt			
Drill hole Ol-239. Coordinates, 19,885N, 11,665E. Elevation, 2,774 feet					
Qp	4.0	Soil and Palouse formation			
Tlu	14.3	Clay, transported, yellow-brown	16.0	11.5	34.2
	19.3	Clay, transported, brown-gray, micaceous	14.0	13.3	30.9
	24.3	Clay, transported, brown-gray, micaceous	11.9	10.7	29.1
	29.3	Clay, transported, yellow-gray, micaceous			
KJg	34.3	Clay; residual from granodiorite; greenish-gray; micaceous.			
	39.3	Clay; residual from granodiorite; yellow-brown: micaceous.	6.4	7.9	16.8
	44.3	Clay; residual from granodiorite; brown; sandy			
	49.3	Clay; residual from granodiorite; green and brown; sandy.	3.5	6.6	7.8
	54.3	Clay; residual from granodiorite; green and brown, sandy.	2.4	5.4	4.9
		Granodiorite			
Drill hole Ol-240. Coordinates, 14,940N, 10,550E. Elevation, 2,833 feet					
Qp	15.5	Soil and Palouse formation			
Tc		Basalt			
Drill hole Ol-241. Coordinates, 14,890N, 11,590E. Elevation, 2,753 feet					
Qp	9.8	Soil and Palouse formation			
Tc		Basalt			
Drill hole Ol-251. Coordinates, 2,350N, 8,495E. Elevation, 2,743 feet					
Qp	20.2	Soil and Palouse formation			
Tc		Basalt			
Drill hole Ol-252. Coordinates, 2,540N, 9,775E. Elevation, 2,794 feet					
Qp	22.5	Soil and Palouse formation			
Tc		Basalt			
Drill hole Ol-253. Coordinates, 3,505N, 19,640E. Elevation, 2,768 feet					
Qp	12.0	Soil and Palouse formation			
Tc		Basalt			

Drill hole logs and assay data of the Olson deposit—Continued

Formation	Depth (feet)	Description	Ignition loss	Availability Fe_2O_3	Availability Al_2O_3
Drill hole O1-254. Coordinates, 3,430N, 18,080E. Elevation, 2,815 feet					
Qp	22.5	Soil and Palouse formation			
Tcl	23.0	Clay; residual from basalt; black	9.5	18.2	24.5
	28.0	Clay; residual from basalt; yellow-brown			
	35.8	----do	9.8	16.2	27.0
	40.8	Clay; residual from basalt; brown; yellow-streaked	9.7	18.1	24.0
	44.8	Clay; residual from basalt; brown			
	46.0	Clay; residual from bsalt; contains light-green nontronite.	7.3	21.3	16.6
	47.9	Clay; residual from basalt; light yellow	8.7	15.2	20.8
	52.5	Clay; residual from basalt; brown	9.8	17.6	24.6
	59.5	Clay; residual from basalt; yellow-brown	9.5	17.0	24.3
	61.4	Clay; residual from basalt; brown	9.9	18.6	23.4
	64.0	Clay; residual from basalt; yellow-brown	9.9	16.5	23.7
	72.8	Clay; residual from basalt; brown	10.4	17.0	23.6
	74.2	Clay; residual from basalt; yellow, green, and brown	9.5	16.5	21.9
	75.3	Clay; residual from basalt; yellow	9.6	9.8	25.1
	76.0	Clay; residual from basalt; dark blue	9.1	14.5	22.0
	77.9	Clay; residual from basalt; yellow	9.4	12.8	24.4
	82.9	Clay; residual from basalt; blue, yellow, and brown	9.2	13.9	24.9
	87.9	Clay; residual from basalt; dark blue			
	90.2	----do	8.6	16.8	19.4
		Basalt			
Drill hole O1-255. Coordinates, 4,120N, 16,645E. Elevation, 2,830 feet					
Qp	18.4	Soil and Palouse formation			
Tcl	23.4	Clay; residual from basalt; contains nontronite	10.1	15.3	22.5
	28.2	----do	10.3	13.3	23.2
	33.2	Clay; residual from basalt; blue; contains streaks of nontronite.	9.1	16.9	20.0
	38.2	Clay; residual from basalt; yellow	10.4	19.7	22.5
	41.3	Clay; residual from basalt; brown			
	46.3	Clay; residual from basalt; yellow	10.8	20.2	22.1
	51.3	Clay; residual from basalt; brown			
	61.3	----do	10.4	20.3	23.2
	71.3	----do	10.0	21.0	23.0
	76.3	----do	9.4	19.8	22.4
	81.3	Clay; residual from basalt; yellow-brown			
	86.3	----do	9.1	19.4	22.0
	88.6	----do	9.1	19.0	20.8
	93.3	Clay; residual from basalt; brown	8.7	18.3	21.4
		Basalt			
Drill hole O1-256. Coordinates, 780N, 15,280E. Elevation, 2,795 feet					
Qp	34.0	Soil and Palouse formation			
Tc		Basalt			
Drill hole O1-258. Coordinates, 3,000N, 12,645E. Elevation, 2,859 feet					
Qp	6.2	Soil and Palouse formation			
Tlu	7.0	Limonite			
Tcl	12.0	Clay; residual from basalt; brown, speckled with white	9.8	18.5	23.9
	17.0	----do	9.8	20.4	23.6
	22.0	----do	10.0	20.7	23.9
	32.0	----do	9.4	19.3	22.3
	37.0	Clay; residual from basalt; yellow, gray, and blue	9.3	16.6	22.8
	47.0	Clay; residual from basalt; light yellow; brown-streaked	9.0	22.4	21.4
	57.0	----do	8.8	24.2	20.7
	67.0	Clay; residual from basalt; yellow and brown	8.8	21.8	22.1
	72.0	----do	8.4	22.1	20.7
	77.0	----do	8.4	21.2	21.4
	82.0	----do	8.3	19.4	21.4
	87.0	----do	8.4	17.7	22.5
	91.8	Clay; residual from basalt; brown; yellow-streaked	7.7	20.1	20.6
		Basalt			

Drill hole logs and assay data of the Olson deposit—Continued

Formation	Depth (feet)	Description	Ignition loss	Availability Fe_2O_3	Availability Al_2O_3
Drill hole OI-260. Coordinates, 4,370N, 13,320E. Elevation, 2,872 feet					
Qp	6.0	Soil and Palouse formation			
Tlu	9.7	Clay, transported, yellow, sandy	10.0	5.7	27.4
	12.9	Clay, transported, yellow, slightly sandy, micaceous	8.5	5.5	23.6
	16.2	Clay, transported, light gray, plastic	12.0	3.0	34.6
Tcl	26.2	Clay; residual from basalt; dark brown and blue; spotted white with amygdules of kaolin.	10.6	18.5	26.4
	31.2	do	10.0	25.0	23.6
	41.2	do	10.6	22.0	23.3
	46.2	Clay; residual from basalt; light brown and blue; orange-streaked.	10.6	22.9	23.3
	56.2	Clay; residual from basalt; yellow and brown; some black.	10.6	24.0	23.2
	66.2	do	10.6	25.1	23.5
	71.2	do	10.5	23.7	23.7
	81.2	Clay; residual from basalt; yellow; brown and blue-streaked.			
	91.2	do	9.5	23.9	21.2
	96.2	Clay; residual from basalt; yellow; brown and blue-streaked.	9.4	21.1	22.5
	101.2	Clay; residual from basalt; brown and yellow; contains amygdules of nontronite.			
	106.2	Clay; residual from basalt; brown and yellow	8.6	20.9	19.6
		Basalt			
Drill hole OI-261. Coordinates, 6,800N, 16,610E. Elevation, 2,861 feet					
Qp	3.4	Soil and Palouse formation			
Tcl	8.4	Clay; residual from basalt; brown	10.8	21.3	24.8
	18.4	do	10.8	20.7	25.1
	23.4	do	10.6	20.8	24.3
	28.4	do	10.6	19.9	25.2
	33.4	Clay; residual from basalt; brown; orange-streaked			
	43.4	do	11.0	23.4	25.6
	53.4	do	10.9	26.2	24.9
	63.4	do	10.7	26.2	24.7
	73.4	do	10.8	26.4	23.9
	83.4	Clay; residual from basalt; black; spotted white with amygdules of kaolin.	10.7	22.1	23.9
	93.4	do	10.7	21.6	24.4
	98.4	Clay; residual from basalt; yellow	11.2	24.2	24.8
	104.4	Clay; residual from basalt; black; spotted white with amygdules of kaolin.	10.0	21.8	23.6
		Basalt			
Drill hole OI-262. Coordinates, 7,710N, 17,160E. Elevation, 2,848 feet					
Qp	11.5	Soil and Palouse formation			
Tcl	21.5	Clay; residual from basalt; brown	10.0	23.7	23.9
	31.5	do	10.0	24.2	22.8
	41.5	do	10.2	22.2	22.4
	51.5	Clay; residual from basalt; yellow-brown	10.0	20.5	21.2
	56.5	do	10.0	20.8	20.9
	58.0	Clay; residual from basalt; brown			
	59.0	Clay; residual from basalt; brown; contains green nontronite.	8.8	23.2	16.0
	64.0	Clay; residual from basalt; brown	9.9	21.2	21.3
	69.0	Clay; residual from basalt; yellow-brown			
	74.0	Clay; residual from basalt; dark-blue and brown			
	79.0	Clay; residual from basalt; dark-brown; contains pale-green nontronite.	9.5	18.9	20.8
	82.3	Clay; residual from basalt; dark-brown and blue; speckled yellow.			
	84.0	Clay; residual from basalt; yellow-brown	8.9	20.2	19.5
	86.7	do	9.2	19.2	19.8
	94.7	do	8.5	16.4	20.4
	96.2	Clay; residual from basalt; green and brown	8.3	20.0	18.2
	102.7	Clay; residual from basalt; blue and brown	8.8	18.4	19.6
		Basalt			

Drill hole logs and assay data of the Olson deposit—Continued

Formation	Depth (feet)	Description	Ignition loss	Availability Fe_2O_3	Availability Al_2O_3
Drill hole OI-263. Coordinates, 8,405N, 17,620E. Elevation, 2,785 feet					
Qp	8.3	Soil and Palouse formation			
Tcl	13.3	Clay; residual from basalt; blue, brown, and yellow	9.7	21.0	22.4
	15.6	Clay; residual from basalt; blue and brown			
	19.6	Clay; residual from basalt; dark-brown and yellowish-brown.	9.8	22.3	21.4
	24.4	do	8.8	20.8	19.1
	27.1	Clay; residual from basalt; brown; contains green nontronite.	8.2	23.5	16.0
	37.1	Clay; residual from basalt; brown, blue, and yellow-brown.	9.5	18.0	21.1
	41.0	Clay; residual from basalt; dark-brown and blue	9.5	18.0	20.4
		Basalt			
Drill hole OI-264. Coordinates, 8,465N, 16,035E. Elevation, 2,829 feet					
Qp	31.3	Soil and Palouse formation			
Tcl	36.3	Clay; residual from basalt; yellow-brown	9.8	20.1	21.4
	46.3	do	11.3	22.6	25.3
	47.0	do	10.9	21.6	23.2
	57.0	Clay; residual from basalt; blue-brown			
	67.0	Clay; residual from basalt; yellow-brown	10.2	21.1	22.7
	72.5	do	9.9	17.7	21.8
		Basalt			
Drill hole OI-265. Coordinates, 1,760N, 9,460E. Elevation, 2,848 feet					
Qp	4.7	Soil and Palouse formation			
Tcl	9.7	Clay; residual from basalt; brownish-yellow	11.4	12.5	26.9
	11.2	Clay; residual from basalt; blue and yellow-brown	11.0	9.2	28.8
	12.1	Clay; residual from basalt; blue; spotted brown	11.0	5.7	30.0
	17.1	Clay; residual from basalt; contains some limonite	9.5	23.5	22.9
	20.1	Clay; residual from basalt; brown			
Tll	22.1	Clay; transported, yellow-brown, sandy, micaceous	4.5	5.7	11.7
Tcl	27.1	Clay; residual from basalt; dark-brown	9.3	21.4	26.9
	32.1	Clay; residual from basalt; brown			
	37.1	do	10.0	21.2	22.8
	42.1	Clay; residual from basalt; yellow-gray			
	47.1	Clay; residual from basalt; yellow-brown, brown-gray, and some blue.	9.4	20.9	21.3
	51.2	Clay; residual from basalt; greenish-gray; contains nontronite.			
	56.2	Clay; residual from basalt; blue and brown	8.4	18.2	19.9
	61.2	Clay; residual from basalt; yellow-brown	8.5	21.0	19.7
	71.2	do	8.3	20.9	18.6
	81.2	do	8.5	20.4	21.1
	86.0	Clay; residual from basalt; yellow and brown	8.0	20.1	19.1
	88.6	Clay; residual from basalt; brown	8.7	19.3	21.5
	93.6	Clay; residual from basalt; yellow and some brown	8.2	19.6	20.6
	98.6	Clay; residual from basalt; yellow			
	109.3	Clay; residual from basalt; yellow-brown	7.5	18.5	18.6
		Basalt			
Drill hole OI-266. Coordinates, 3,440N, 11,540E. Elevation, 2,822 feet					
Qp	6.7	Soil and Palouse formation			
Tcl	11.7	Clay; residual from basalt; brown; blue-stained	10.8	23.2	24.6
	21.7	Clay; residual from basalt; brown; speckled with white	11.0	25.5	25.3
	26.7	do	11.2	25.8	24.7
	31.7	Clay; residual from basalt; yellow and brown			
	41.7	do	11.1	26.4	25.3
	51.7	do	11.5	25.8	25.1
	56.7	do			
	61.7	Clay; residual from basalt; yellow and brown; thin layers of hard, blue basalt containing amygdules of nontronite.	10.6	25.6	24.2
	71.7	Clay; residual from basalt; dark brown; contains white phenocrysts.	10.0	24.6	23.1
	76.7	Clay; residual from basalt; blue, with very little yellow	8.9	19.9	19.9
	81.7	Clay; residual from basalt; blue and brown, speckled with yellow and green; contains nontronite amygdules.			

Drill hole logs and assay data of the Olson deposit—Continued

Formation	Depth (feet)	Description	Ignition loss	Availability Fe_2O_3	Availability Al_2O_3
		Drill hole Ol-266—Continued			
Tlu	88.5	Clay; residual from basalt; blue	8.7	15.6	21.2
	89.0	Clay; residual from basalt; yellow and brown	8.2	21.3	19.4
	99.0	Clay; residual from basalt; blue; some yellow and brown, speckled with white.	8.8	17.5	21.1
	104.0	Clay; residual from basalt; dark blue; contains white phenocrysts.	8.4	18.2	21.3
	109.0	Clay; residual from basalt; dark-blue, brown, and yellow.			
	114.0	Clay; residual from basalt; blue; contains white kaolin amygdules.	8.9	17.7	19.9
	119.0	Clay; residual from basalt; blue, brown, and yellow; stained with green nontronite.			
	130.3	Clay; residual from basalt; brown and yellow	8.9	17.9	20.2
		Basalt			
		Drill hole Ol-267. Coordinates, 1,285N, 12,675E. Elevation, 2,789 feet			
Qp	26.5	Soil and Palouse formation			
Tc		Basalt			
		Drill hole Ol-269. Coordinates, 16,110N, 19,250E. Elevation, 2,719 feet			
Qp	28.5	Soil and Palouse formation			
Tll	29.7	Clay, transported, yellow-white, sandy	5.0	4.9	12.6
	37.0	Clay, transported, yellow-gray, plastic	10.1	11.7	24.4
	44.7	Limonite	9.4	41.6	13.2
Tcl	49.5	Clay; residual from basalt; yellow-black	8.5	24.5	14.2
		Basalt			
		Drill hole Ol-271			
Qp	26.1	Soil and Palouse formation			
Tcl	26.5	Clay; residual from basalt; blue			
		Basalt			
		Drill hole Ol-273. Coordinates, 13,995N, 9,540E. Elevation, 2,850 feet			
Qp	44.0	Soil and Palouse formation			
Tc		Basalt			
		Drill hole Ol-274. Coordinates, 13,975N, 8,540E. Elevation, 2,836 feet			
Qp	16.3	Soil and Palouse formation			
Tlu	19.9	Clay, transported, gray, speckled brown	7.1	4.3	19.1
	22.0	Clay, transported, blue-gray, plastic	8.7	2.8	24.1
	23.8	Clay, transported, brown, sandy, limonitic	5.0	5.8	12.1
	25.3	Clay, transported, light-brown and gray	7.7	10.6	19.9
	28.5	Clay, transported, brown to red-brown	7.3	18.3	15.9
Tcl	33.5	Clay; residual from basalt; blue	9.2	14.3	22.6
	38.5	Clay; residual from basalt; blue, brown, and yellow			
	48.5	Clay; residual from basalt; green-brown and blue	8.9	15.6	22.4
	58.5	----do	8.6	17.9	20.5
	63.0	Clay; residual from basalt; green and brown, contains thin limonite band.	8.6	20.8	19.2
	68.0	Clay; residual from basalt; green-blue and brown	8.6	17.9	21.7
	68.8	Clay; residual from basalt; blue			
		Basalt			

Drill hole logs and assay data of the Olson deposit—Continued

Formation	Depth (feet)	Description	Ignition loss	Availability Fe_2O_3	Availability Al_2O_3
Drill hole Ol-275. Coordinates, 14,025N, 7,580E. Elevation, 2,821 feet					
Qp	2.0	Soil and Palouse formation			
Tlu	7.0	Clay, transported, brown, sandy	4.2	5.0	8.5
	12.0	Clay, transported, white, sandy	6.7	2.9	14.7
	22.0	Clay, transported, gray, plastic	9.3	1.7	23.0
	24.3	Clay, transported, yellow-gray, plastic	11.8	2.2	31.7
	29.3	do	10.7	3.8	27.6
	34.3	Clay, transported, yellow-white, sandy, micaceous	4.8	2.5	11.6
	39.0	do	6.0	5.5	13.8
	39.2	Limonite			
	44.2	Clay, transported, yellow-white, sandy, micaceous	5.0	3.7	10.8
	49.2	do	2.1	1.3	5.3
	59.2	do	5.4	1.8	14.7
	65.7	do	6.0	1.9	16.5
	68.4	Limonite	7.4	16.4	14.7
	73.4	Clay, transported, pink-gray, plastic	7.6	2.9	17.6
	76.6	do	9.6	2.4	23.4
KJg		Granodiorite			
Drill hole Ol-276. Coordinates, 14,860N, 12,600E. Elevation, 2,776 feet					
Qp	4.0	Soil and Palouse formation			
Tc		Basalt			
Drill hole Ol-277. Coordinates, 14,960N, 9,575E. Elevation, 2,793 feet					
Qp	3.0	Soil and Palouse formation			
Tcl	4.7	Clay, residual from basalt, blue	6.7	3.9	19.3
		Basalt			
Drill hole Ol-278. Coordinates, 14,970N, 8,550E. Elevation, 2,856 feet					
Qp	15.8	Soil and Palouse formation			
Tlu	25.8	Clay, transported, white, sandy, micaceous	4.9	1.8	14.4
	35.8	do	4.6	1.4	12.4
	45.8	do	4.6	1.7	12.4
	55.8	do	3.6	1.2	10.4
	63.9	do	2.7	1.3	7.6
KJg		Granodiorite			
Drill hole Ol-279. Coordinates, 15,000N, 7,535E. Elevation, 2,858 feet					
Qp	16.7	Soil and Palouse formation			
Tlu	20.0	Clay, transported, brownish-yellow	9.1	3.4	25.4
	20.8	Clay, transported, brown, sandy			
	24.5	Clay, transported, yellow	9.3	9.1	22.1
	26.0	Clay, transported, pinkish-gray	10.4	2.5	27.6
	27.4	Clay, transported, yellow			
	32.4	Clay, transported, pink-gray, plastic	10.4	1.4	27.6
	37.4	Clay, transported, gray, plastic	8.7	1.0	23.6
	41.2	Clay, transported, light-gray, plastic			
	46.2	Clay, transported, pale-yellow and gray, slightly sandy and micaceous.	6.7	1.6	17.2
	47.5	Clay, transported, yellow, sandy, micaceous			
	47.8	Limonite			
	52.8	Clay, transported, brownish-yellow, micaceous	6.0	6.8	13.5
	57.8	Clay, transported, brownish-yellow, sandy, micaceous			
	65.3	do	4.9	2.7	12.6
	66.1	Clay, transported, gray, and brown, sandy	4.4	1.9	11.1
	69.2	Clay, transported, yellow-brown, sandy			
	70.0	Clay, transported, light-gray	7.9	4.1	19.2
	73.3	Clay, transported, yellow-brown			
	79.4	Clay, transported, gray	7.3	1.4	20.5
	84.4	Clay, transported, gray and brown, sandy	4.4	1.8	10.6
	85.3	Clay, transported, brown, sandy			
KJg		Granodiorite			

Drill hole logs and assay data of the Olson deposit—Continued

Formation	Depth (feet)	Description	Ignition loss	Availability Fe_2O_3	Availability Al_2O_3
Drill hole Ol-280. Coordinates, 15,455N, 10,095E. Elevation, 2,784 feet					
Qp	8.5	Soil and Palouse formation			
Tlu	11.8	Clay, transported, gray, plastic	9.2	2.1	26.1
	13.5	Clay, transported, yellow and gray, slightly sandy, plastic.	6.7	1.4	19.5
	15.2	Clay, transported, gray, plastic	9.6	1.8	27.7
	20.2	Clay, transported, gray, slightly sandy, plastic	6.6	1.3	19.2
	22.2	Clay, transported, gray, sandy			
	27.2	Clay, transported, gray, slightly sandy, plastic	7.9	1.2	23.6
	29.5	Clay, transported, yellow-brown	8.0	5.0	20.8
Tcl	31.0	Clay; residual from basalt; pale-yellow	8.7	5.8	21.8
		Basalt			
Drill hole Ol-281. Coordinates, 15,505N, 8,545E. Elevation, 2,774 feet					
Qp	10.8	Soil and Palouse formation			
Tlu	12.9	Clay, transported, yellow, sandy, micaceous	5.2	5.7	11.4
	15.5	Clay, transported, yellow, thin limonite bands	10.0	26.1	21.0
	20.5	Clay, transported, gray, plastic	10.2	5.3	24.6
	25.5	Clay, transported, gray and yellow	9.6	10.8	24.3
	29.3	Clay, transported, yellow			
	34.3	Clay, transported, yellow and gray, plastic	10.0	7.0	25.5
	35.9	Clay, transported, pinkish red, plastic	9.5	8.0	27.2
KJg		Granodiorite			
Drill hole Ol-282. Coordinates, 15,470N, 9,085E. Elevation, 2,752 feet					
Qp	14.0	Soil and Palouse formation			
KJg		Granodiorite			
Drill hole Ol-283. Coordinates, 15,465N, 9,600E. Elevation, 2,764 feet					
Qp	4.0	Soil and Palouse formation			
KJg		Granodiorite			
Drill hole Ol-284. Coordinates, 15,525N, 8,040E. Elevation, 2,768 feet					
Qp	12.5	Soil and Palouse formation			
KJg		Granodiorite			
Drill hole Ol-285. Coordinates, 15,560N, 7,535E. Elevation, 2,851 feet					
Qp	9.2	Soil and Palouse formation			
Tlu	19.2	Clay, transported, white, sandy	4.3	1.2	10.4
	29.2	----do	4.1	1.1	9.1
	39.2	----do	3.9	1.1	9.3
	49.2	----do	3.2	1.1	6.3
	60.7	----do	2.4	1.1	5.3
KJg		Granodiorite			
Drill hole Ol-286. Coordinates, 12,975N, 9,535E. Elevation, 2,846 feet					
Qp	25.1	Soil and Palouse formation			
Tcl	28.8	Clay; residual from basalt; blue, yellow, and brown	7.9	13.2	16.6
		Basalt			
Drill hole Ol-287. Coordinates, 12,985N, 8,540E. Elevation, 2,843 feet					
Qp	18.3	Soil and Palouse formation			
Tc		Basalt			

Drill hole logs and assay data of the Olson deposit—Continued

Formation	Depth (feet)	Description	Ignition loss	Availability Fe_2O_3	Availability Al_2O_3
Drill hole Ol-289. Coordinates, 11,500N, 15,495E. Elevation, 2,798 feet					
Qp	2.4	Soil and Palouse formation			
Tlu	7.4	Clay, transported, yellow, sandy	4.9	2.1	12.9
	9.4	Clay, transported, yellow-brown			
	14.4	Clay, transported, blue-gray and pink-gray, plastic	11.3	2.2	30.1
	21.1	Clay, transported, pink-gray, plastic			
Tcl	24.0	Clay; residual from basalt; yellow	8.6	6.1	20.9
		Basalt			
Drill hole Ol-290. Coordinates, 11,000N, 15,500E. Elevation, 2,820 feet					
Qp	20.5	Soil and Palouse formation			
Tlu	23.7	Clay, transported, yellow	11.3	7.2	24.4
	26.7	Clay, transported, gray, yellow, sandy streaks	7.0	1.4	18.6
	35.6	Clay, transported, gray, sandy; water at 30 feet	3.3	1.0	7.4
	40.6	Clay, transported, pinkish-gray, plastic, white-streaked.	9.8	2.8	23.7
	45.6	Clay, transported, pink-gray, plastic			
	49.7	Clay, transported, pink-gray	7.9	2.3	20.4
Tcl	52.1	Clay; residual from basalt; yellow	7.4	5.6	17.2
		Basalt			
Drill hole Ol-291. Coordinates, 10,500N, 15,500E. Elevation, 2,801 feet					
Qp	5.7	Soil and Palouse formation			
	6.3	Clay, transported, gray	5.0	4.1	10.4
	8.8	Clay, transported, yellow	10.8	7.6	26.7
	10.0	Clay, transported, gray	11.1	1.8	29.3
	12.8	Clay, transported, brown, gray, and yellow, sandy	4.3	1.6	8.0
	15.3	Clay, transported, brownish-yellow	11.2	3.2	28.4
	16.4	Clay, transported, brown-gray, plastic			
	21.4	Clay, transported, pink-gray, plastic, white-streaked	11.2	2.7	28.5
	26.4	Clay, transported, pink-gray, plastic			
Tcl	27.5	Clay; residual from basalt; yellow			
		Basalt			
Drill hole Ol-292. Coordinates, 10,500N, 15,000E. Elevation, 2,836 feet					
Qp	15.0	Soil and Palouse formation			
Tlu	17.3	Clay, transported, yellow-brown	8.4	2.0	22.8
	18.7	Clay, transported, yellow-brown, sandy	10.2	2.3	27.3
	21.0	Clay, transported, yellow			
	25.0	Clay, transported, orange, sandy, micaceous	3.2	1.5	8.7
	28.5	Clay, transported, yellow and gray, plastic	10.7	6.5	27.4
	33.0	Clay, transported, yellow and red-brown			
	35.7	Clay, transported, yellow, sandy	6.3	0.9	16.3
	39.0	Clay, transported, purple-gray			
	44.5	Clay, transported, gray, sandy	3.1	0.8	7.4
	49.5	Clay, transported, gray to dark brown, plastic	12.4	2.5	28.5
	59.5	do			
	61.5	Clay, transported, pink-gray, plastic			
Tcl	64.8	Clay; residual from basalt; yellow and brown	8.0	11.8	17.8
		Basalt			
Drill hole Ol-293. Coordinates, 10,580N, 16,000E. Elevation, 2,797 feet					
Qp	14.0	Soil and Palouse formation			
Tc		Basalt			

Drill hole logs and assay data of the Olson deposit—Continued

Formation	Depth (feet)	Description	Ignition loss	Availability Fe_2O_3	Availability Al_2O_3
Drill hole Ol-294. Coordinates, 9,997N, 15,505E. Elevation, 2,840 feet					
Qp	25.0	Soil and Palouse formation			
Tlu	26.5	Clay, transported, brownish-yellow	7.9	4.1	20.4
	29.3	Clay, transported, light-yellow, sandy	8.2	2.1	21.6
	31.5	Clay, transported, yellow-brown, sandy	6.2	2.7	15.9
	33.6	Clay, transported, yellow	8.6	3.5	22.3
	36.5	Clay, transported, gray and brown, sandy			
	37.0	Clay, transported, yellow, limonite	10.4	5.7	26.0
	40.8	Clay, transported, yellow-brown			
	42.5	Clay, transported, yellow-brown, sandy	7.7	7.3	17.4
	43.9	Clay, transported, yellow and gray	10.3	3.5	26.0
	48.9	Clay, transported, gray and pink, plastic	11.9	2.0	31.4
	54.5	Clay, transported, pink-gray, plastic			
Tcl	56.5	Clay; residual from basalt; blue and gray	10.1	3.6	28.0
		Basalt			
Drill hole Ol-295. Coordinates, 10,000N, 14,515E. Elevation, 2,791 feet					
Qp	6.4	Soil and Palouse formation			
Tc		Basalt			
Drill hole Ol-296. Coordinates, 9,495N, 14,520E. Elevation, 2,785 feet					
Qp	4.5	Soil and Palouse formation			
Tc		Basalt			
Drill hole Ol-297. Coordinates, 9,500N, 15,010E. Elevation, 2,808 feet					
Qp	11.2	Soil and Palouse formation			
Tlu	11.6	Clay, transported, pink-gray, plastic	9.8	5.0	28.1
Tcl	14.0	Clay; residual from basalt; blue			
		Basalt			
Drill hole Ol-298. Coordinates, 9,500N, 15,510E. Elevation, 2,863 feet					
Qp	22.5	Soil and Palouse formation			
Tlu	26.5	Clay, transported, yellow	10.2	4.8	25.4
	28.0	Clay, transported, yellow and brown, sandy	7.5	3.2	20.5
	30.0	Clay, transported, yellow	11.3	3.0	30.9
	32.8	Clay, transported, gray and yellow	10.6	2.3	29.3
	33.5	Clay, transported, yellow-brown, sandy	5.9	2.8	15.5
	37.3	Clay, transported, light-yellow and gray	10.6	2.1	29.4
	38.2	Clay, transported, brown	5.5	5.9	13.6
	40.5	Clay, transported, brown, sandy			
	44.5	Clay, transported, brown-yellow	9.4	6.2	24.2
	46.0	Clay, transported, brown-yellow, sandy	4.8	3.9	12.0
	54.2	Clay, transported, yellow, plastic	10.5	8.9	25.8
	56.4	Clay, transported, light-gray, sandy	4.5	1.4	11.9
	65.0	Clay, transported, pink-gray, plastic	11.7	2.1	31.8
Tcl	73.0	Clay; residual from basalt; yellow	9.1	8.7	24.4
		Basalt			
Drill hole Ol-299. Coordinates, 9,500N, 16,010E. Elevation, 2,816 feet					
Qp	35.3	Soil and Palouse formation			
Tcl		Basalt			
Drill hole Ol-300. Coordinates, 8,990N, 14,525E. Elevation, 2,824 feet					
Qp	35.3	Soil and Palouse formation			
Tc		Basalt			

Drill hole logs and assay data of the Olson deposit—Continued

Formation	Depth (feet)	Description	Ignition loss	Availability Fe_2O_3	Availability Al_2O_3
Drill hole OI-301. Coordinates, 8,505N, 14,530E. Elevation, 2,808 feet					
Qp	21.8	Soil and Palouse formation			
Tcl	25.1	Clay; residual from basalt; blue	6.6	13.1	17.7
		Basalt			
Drill hole OI-302. Coordinates, 9,005N, 15,515E. Elevation, 2,836 feet					
Qp	15.8	Soil and Palouse formation			
Tlu	19.2	Clay, transported, brown	8.2	6.1	21.8
	20.4	Clay, transported, gray, sandy	8.2	2.6	22.6
	22.5	Clay, transported, brown and yellow-brown, sandy	5.6	5.4	14.7
	28.0	Clay, transported, brownish yellow	11.2	10.4	29.3
	29.5	Clay, transported, yellow-brown, sandy	7.8	2.1	22.6
	34.5	Clay, transported, pink-gray, plastic, white-streaked	12.4	1.8	34.3
	36.0	Clay, transported, pink-gray, plastic	10.6	7.2	28.4
Tcl	41.0	Clay; residual from basalt; blue and blue-gray	10.2	10.1	25.9
	46.0	Clay; residual from basalt; blue-gray	8.6	24.8	16.5
	48.0	Clay; residual from basalt; yellow-brown			
		Basalt			
Drill hole OI-303. Coordinates, 8,500N, 15,500E. Elevation, 2,789 feet					
Qp	12.3	Soil and Palouse formation			
Tcl	16.6	Clay; residual from basalt; greenish-blue	8.0	16.7	19.3
		Basalt			
Drill hole OI-304. Coordinates, 8,505N, 15,025E. Elevation, 2,772 feet					
Qp	5.0	Soil and Palouse formation			
Tc		Basalt			
Drill hole OI-305. Coordinates, 13,990N, 16,000E. Elevation, 2,849 feet					
Qp	8.0	Soil and Palouse formation			
Tlu	14.5	Clay, transported, yellow; streaked with gray plastic clay.	9.1	3.4	25.1
	15.6	Clay, transported, yellow, sandy, micaceous	6.2	2.8	16.9
	20.6	Clay, transported, yellow	9.9	2.6	28.5
	22.5	Clay, transported, yellow and gray			
	24.5	Clay, transported, yellow, sandy	6.2	3.4	16.7
	28.0	Clay, transported, yellow and pink, plastic	8.5	3.4	23.6
	36.8	Clay, transported, yellow; streaked with gray plastic clay.	9.9	5.3	26.5
	39.5	Clay, transported, pink and gray, plastic	11.2	2.3	31.2
	40.1	Clay, transported, gray, sandy			
	45.1	Clay, transported, brown, plastic	11.8	2.3	32.6
	47.7	Clay, transported, pink and gray, plastic			
Tcl	50.0	Clay, glue; residual from basalt	10.4	16.3	23.9
		Basalt			
Drill hole OI-306. Coordinates, 13,500N, 16,000E. Elevation, 2,817 feet					
Qp	11.8	Soil and Palouse formation			
Tcl	20.2	Clay, transported, gray and yellow	7.7	17.4	16.6
Drill hole OI-307. Coordinates, 13,990N, 15,500E. Elevation, 2,799 feet					
Qp	5.0	Soil and Palouse formation			
Tcl	13.2	Clay; residual from basalt; blue	8.5	16.3	20.5
		Basalt			

Drill hole logs and assay data of the Olson deposit—Continued

Formation	Depth (feet)	Description	Ignition loss	Availability Fe_2O_3	Availability Al_2O_3
Drill hole OI-308. Coordinates, 13,990N, 16,500E. Elevation, 2,797 feet					
Qp	8.0	Soil and Palouse formation			
Tcl	13.7	Clay; residual from basalt; blue and yellow	7.3	16.8	17.4
		Basalt			
Drill hole N-1. Coordinates, 5,535N, 16,955E. Elevation, 2,865 feet					
Qp	2.0	Soil and Palouse formation			
Tlu	5.3	Clay, transported, yellow	10.5	3.9	26.5
	6.5	Clay, transported, gray	10.2	1.3	26.9
	10.5	Clay, transported, brown, sandy, micaceous	2.6	1.8	5.8
	15.5	Clay, transported, yellow and gray-yellow	9.7	2.0	27.4
	19.2	Clay, transported, yellow, sandy, micaceous	3.9	2.6	10.0
	22.9	Clay, transported, brown	11.1	3.1	29.9
	28.5	Clay, transported, brown, very sandy	4.0	1.6	10.7
Tcl	34.5	Clay; residual from basalt; blue, gray, and yellow	10.7	3.1	28.3
	39.5	Clay; residual from basalt; yellow-brown	10.7	17.1	25.4
	44.5	Clay; residual from basalt; yellow-brown and blue			
	49.5	do	10.2	22.0	21.8
	54.5	Clay; residual from basalt; brown			
	59.0	Clay; residual from basalt; brown, blue; contains pale green nontronite.	8.5	20.4	20.0
	64.0	Clay; residual from basalt; brown and blue			
	69.0	Clay; residual from basalt; blue-brown and yellow-brown.	8.3	17.1	20.0
	79.0	Clay; residual from basalt; yellow-brown			
	84.0	do	8.1	17.2	19.9
	94.0	do	8.2	17.5	18.9
	100.6	Clay; residual from basalt; brown	8.6	16.9	20.6
		Basalt			
Drill hole NB-1. Coordinates, 6,160N, 17,270E. Elevation, 2,880 feet					
Qp	9.0	Soil and Palouse formation			
Tlu	14.0	Clay, transported, gray-yellow	11.0	3.3	27.9
	15.5	Clay, transported, white, yellow-stained			
	18.0	Clay, transported, yellow, sandy	4.1	1.6	9.6
Tcl	20.5	Clay; residual from basalt; brown	11.4	4.2	30.8
	23.9	Clay; residual from basalt; gray-blue	11.4	4.7	30.0
	24.2	Clay; residual from basalt	10.9	14.6	26.5
	29.2	Clay; residual from basalt; brown	10.4	24.5	23.0
	34.2	do	10.0	22.6	23.8
	37.8	Clay; residual from basalt; yellow-gray	9.1	19.9	21.6
	41.7	Clay; residual from basalt; brown	9.8	21.5	22.7
	44.2	Clay; residual from basalt; brown, blue, and gray	8.8	19.1	21.7
	46.2	Clay; residual from basalt; light brown	8.4	19.9	20.7
	51.2	Clay; residual from basalt; brown and gray	8.1	20.7	19.9
	53.9	Clay; residual from basalt; blue-gray	7.2	14.5	19.3
	58.6	do	7.6	16.0	17.4
		Basalt			

Drill hole logs and assay data of the Stanford deposit

Formation	Depth (feet)	Description	Available Fe_2O_3	Available Al_2O_3
		Drill hole St-1. Coordinates, 27,410N, 6,750E		
Qp	16.2	Soil and Palouse formation		
		Drill hole St-2. Coordinates 26,310N, 4,950E		
Qp	5.7	Soil and Palouse formation		
Tlu	8.0	Clay, transported, tan sandy, slightly micaceous; contains thin limonite band.	7.7	18.1
	15.2	Clay, transported, light- to dark-gray	1.4	29.8
	17.4	Clay, transported, light-gray; contains pinkish-gray streaks and many small kaolin lumps.	1.1	33.8
	25.0	Clay, transported, light-yellow, sandy, slightly micaceous; contains iron-stained layers.	1.0	18.3
		Drill hole St-3. Coordinates 27,150N, 7,440E		
Qp	18.0	Soil and Palouse formation		
Tc	22.0	Clay; residual from basalt; green		
		Basalt		
		Drill hole St-4. Coordinates, 26,730N, 12,070E		
Qp	12.0	Soil and Palouse formation; one-fourth inch limonite band		
Tlu	16.0	Clay, transported, white, hard, dry	2.1	17.0
	17.0	Clay, transported, white, iron-stained, hard, dry	7.3	15.9
		Drill hole St-5. Coordinates, 31,170N, 9 230E		
Qp	10.0	Soil and Palouse formation		
Tlu	17.0	Clay, transported, micaceous, iron-stained; contains one thin limonite band.	4.6	15.1
		Drill hole St-6. Coordinates 28,640N, 9,340E. Elevation, 2,789 feet		
Tlu	10.0	Clay, transported, gray and white, plastic	2.0	25.5
	14.0	Clay, transported, sandy, micaceous, iron-stained	2.7	9.0
	20.0	Sand, transported, yellow, micaceous	1.0	4.5
	24.0	----do	1.0	4.2
		Drill hole St-7. Coordinates 26,940N, 2120E		
Qp	13.0	Soil and Palouse formation; last 2 ft. contains half-in. quartz pebbles.		
KJg	17.0	Clay; residual from granodiorite; fine-grained toward bottom	0.9	11.5
		Drill hole St-8. Coordinates, 26,610N, 3,670E		
Tlu	6.0	Clay, transported, iron-stained to white	1.4	21.5
	10.0	Clay, transported, dark-gray		
	12.0	Clay, transported		
	15.5	Clay, transported, sandy, iron-stained	2.6	19.6

Drill hole logs and assay data of the Stanford deposit—Continued

Formation	Depth (feet)	Description	Available Fe_2O_3	Available Al_2O_3
		Drill hole St-9. Coordinates, 26,620N, 3,730E		
Tlu	8.0	Clay, transported, sandy, iron-stained, one-fourth inch limonite band.	2.1	18.7
	9.0	Clay, transported		
	11.0	Clay, transported, white to yellow, sandy	1.1	14.1
	14.0	Clay, transported, white, sandy	0.5	12.1
	18.0	Clay, transported, yellow, sandy; 4-in. beds of waxy white clay; layer of white quartz grains at bottom.	0.7	17.4
		Drill hole St-10. Coordinates 30,890N, 10,080E		
Qp	2.0	Soil and Palouse formation		
	2.5	Limonite		
Tlu	5.0	Clay, transported, yellow, iron-stained	7.0	11.9
	10.0	Clay, transported, white, micaceous	1.0	10.3
	15.0	Clay, transported, white, plastic	0.9	15.9
	16.0	Clay, transported, iron-stained; contains thin limonite bands	4.4	7.8

Drill hole logs and assay data of the Canfield-Rogers deposit

Formation	Depth (feet)	Description	Ignition loss	Availability Fe_2O_3	Availability Al_2O_3
		Drill hole C-1. Coordinates, 17,440N, 23,360E			
Qp	9.4	Soil and Palouse formation			
Tlu	12.2	Sand, transported, red, coarse-grained			
	14.1	Clay, transported, gray and yellow			
	25.7	Sand and gravel, transported, red			
	27.5	Clay, transported, gray			
	29.2	Clay and sand, transported, gray			
	33.7	Clay, transported, gray			
	38.7	Sand, transported, gray and yellow			
	44.0	Gravel, transported, pebble size; water-bearing			
		Drill hole C-2. Coordinates, 28,600N, 14,930E			
Qp	4.5	Soil and Palouse formation			
Tlu	5.7	Clay, transported, yellow, plastic	8.0	2.3	22.7
	8.2	Clay, transported, gray, plastic	6.3	1.4	17.4
	9.6	Clay, transported, gray, sandy			
	12.4	Clay, transported, yellow, plastic	6.9	1.7	20.3
	15.7	Clay, transported, yellow-gray, sandy			
	18.1	Clay, transported, yellow, plastic	9.8	2.0	27.2
	23.1	Clay, transported, gray, sandy; water-bearing	7.1	2.0	20.2
		Drill hole C-3. Coordinates, 28,140N, 13,230E			
Qp	7.5	Soil and Palouse formation			
Tlu	12.0	Sand, transported, yellow-brown, coarse-grained, micaceous, slightly clayey.	2.6	2.1	6.8
	12.6	Sand, transported, gray, coarse-grained			
	17.1	Clay, transported, yellow and gray, plastic	9.1	3.8	25.4
	18.7	Clay, transported, gray, sandy	3.4	1.3	9.7
	21.1	Clay, transported, gray, plastic	9.2	1.9	26.2
	22.1	Clay, transported, gray and yellow, sandy	5.1	1.4	14.7
	25.5	Clay, transported, gray and yellow	9.2	2.9	26.3
	27.5	Clay, transported, yellow and gray, sandy	5.3	2.2	15.8
	32.5	Clay, transported, gray and yellow	8.8	1.9	25.2
	37.5	Clay, transported, light-yellow and gray			
	40.8	Clay, transported, gray, yellow-streaked	9.3	1.9	26.9
	43.7	Clay, transported, gray, sandy	4.5	1.3	13.3
	48.7	Clay, transported, gray, plastic, sandy streaks	9.1	2.9	24.9
	52.2	Clay, transported, yellow and gray; water-bearing			

Drill hole logs and assay data of the Canfield-Rogers deposit—Continued

Formation	Depth (feet)	Description	Ignition loss	Availability Fe_2O_3	Availability Al_2O_3
		Drill hole C-4. Coordinates, 13,960N, 22,050E			
Qp	10.0	Soil and Palouse formation			
Tlu	13.0	Sand, transported; water-bearing			
		Drill hole C-5. Coordinates, 29,270N, 11,560E			
Qal and Qp	7.1	Alluvium and Palouse formation			
Tlu	12.1	Clay, transported, yellow, plastic	3.7	1.7	10.1
	17.1	Clay, transported, yellow and gray	10.4	7.7	26.3
	22.1	Clay, transported, yellow-gray, plastic	8.6	2.7	24.5
	25.9	Clay, transported, pink-yellow, plastic	8.7	4.8	23.0
	30.5	Clay, transported, yellow-gray, sandy	6.0	1.7	16.5
Tcl	35.5	Clay; residual from basalt; blue, yellow-spotted	10.5	6.3	28.3
	40.3	Clay; residual from basalt; blue and brown			
		Basalt			
		Drill hole C-6. Coordinates, 29,590N, 9,940E			
Qp	43.0	Soil and Palouse formation			
Tcl		Basalt			
		Drill hole C-7. Coordinates, 31,040N, 11,290E			
Qp	40.0	Soil and Palouse formation			
		Drill hole C-8. Coordinates, 26,000N, 14,000E			
Qp	3.5	Soil and Palouse formation			
Tlu	10.2	Clay, transported, gray, plastic	9.0	2.6	24.4
	12.3	Clay, transported, gray, sandy	4.6	1.3	12.5
	16.3	Clay, transported, gray, plastic	9.6	2.4	26.4
	17.9	Clay, transported, yellow, sandy	6.3	1.7	16.7
	18.5	Clay, transported, gray, plastic			
	20.1	Clay, transported, gray-yellow, sandy; water-bearing			
	25.1	Clay, transported, gray, plastic, yellow-streaked	9.4	2.0	25.8
	30.1	Clay, transported, gray, plastic			
	33.5	Clay, transported, yellow-gray, sandy	3.3	1.5	7.8
	37.3	Clay, transported, gray, plastic	6.8	2.0	18.8
	40.1	Clay, transported, yellow-gray, sandy			
	44.2	Clay, transported, yellow, plastic	9.5	3.7	24.9
	46.2	Clay, transported, pink-gray, plastic	8.4	2.1	22.1
Tcl	51.2	Clay; residual from basalt; yellow-brown, blue-streaked.	8.6	3.1	23.1
	53.8	Clay; residual from basalt; blue and brown	8.9	2.6	23.6
		Basalt			
		Drill hole C-9. Coordinates, 32,600N, 12,100E			
Qal and Qp	17.5	Alluvium and Palouse formation			
Tcl	19.2	Clay; residual from basalt; blue	3.0	3.9	7.4
	22.5	Clay; residual from basalt; light blue	9.6	3.2	26.7
Tll	27.5	Clay, transported, blue-gray, sandy micaceous			
KJg	29.1	Sand, residual from granodiorite, coarse-grained; water-bearing.	5.0	1.9	14.0

Drill hole logs and assay data of the Canfield-Rogers deposit—Continued

Formation	Depth (feet)	Description	Ignition loss	Availability Fe_2O_3	Availability Al_2O_3
		Drill hole C–10. Coordinates, 32,700N, 14,070E			
Qal and Qp	15.0	Alluvium and Palouse formation; water-bearing at base.			
Tlu	18.1	Clay, transported, gray, sandy	3.6	1.5	9.5
	23.1	Clay, transported, gray and red-brown, very plastic	6.6	2.8	18.6
	28.1	Clay, transported, gray, plastic; interbedded by thin sand beds.	7.4	2.8	21.2
	31.0	Clay, transported, gray, plastic			
KJg		Sand; residual from granodiorite; water-bearing			
		Drill hole C–11. Coordinates, 33,620N, 16,560E			
Qal	10.5	Alluvium			
Qp	12.0	Palouse formation; sand; water-bearing			
Tcl	15.5	Clay; residual from basalt; brown; blue-stained	2.3	3.2	5.3
	20.5	Clay, residual from basalt; blue	2.0	2.6	4.3
Tll	24.3	Clay, transported, sandy			
	28.0	Clay, transported, yellow, sandy, micaceous	4.4	1.9	11.7
KJg	30.5	Sand; residual from granodiorite; coarse-grained	1.7	2.0	4.0
	31.5	Sand; residual from granodiorite; water-bearing; plastic clay underneath.			
		Drill hole C–12. Coordinates, 33,670N, 13,930E			
Qal	12.0	Alluvium; water at 12.0 feet			
Qp	18.0	Palouse formation			
KJg		Gravel; residual from granodiorite; pebble size; water-bearing.			
		Drill hole C–13. Coordinates, 29,850N, 16,480E			
Qp	11.6	Soil and Palouse formation; water at 11.0 feet			
Tlu	16.6	Clay, transported, blue-gray	7.5	1.3	21.7
	19.3	Clay, transported, gray, plastic			
	21.8	Clay, transported, gray, sandy	4.7	1.1	13.7
	26.8	Clay, transported, gray and yellow, plastic	8.1	1.9	24.1
	28.6	Clay, transported, yellow, plastic			
	32.0	Clay, transported, yellow, very sandy; water-bearing	1.4	1.3	4.0

Drill hole logs and assay data of the Stockton deposit

Formation	Depth (feet)	Description	Available Fe_2O_3	Available Al_2O_3
		Drill hole S–1. Coordinates, 3,400X, 13,500Y		
Tl	3.0	Soil		
	7.0	Clay, transported, brown, plastic	2.4	20.4
	11.5	Clay, transported, gray, plastic	2.9	20.8
	16.5	Clay, transported, gray, micaceous, plastic		
	18.5	Clay, transported, red, plastic; water-bearing	1.6	22.8
	22.5	Clay, transported, light brown, sandy	1.1	16.3
	25.5	Clay, transported, chocolate-brown, plastic	1.1	13.8
	28.5	Clay, transported, light-tan, micaceous, plastic	1.1	7.9
KJg	32.0	Clay; residual from granite gneiss; brown	1.7	6.1
	38.5	Clay; residual from granite gneiss; sandy and micaceous	1.0	3.7
	39.5	Clay; residual from granite gneiss; reddish brown	5.3	3.9
	41.0	Clay; residual from granite gneiss; tan; sandy	1.4	4.6
	42.0	Clay; residual from granite gneiss; sandy, limonitic	5.0	9.3
	45.0	Clay; residual from granite gneiss; coarse sandy; limonitic	1.6	11.8
	49.0	Clay; residual from granite gneiss; tan, silty	0.7	11.1
	57.5	Clay; residual from granite gneiss; tan, sandy	0.9	10.1
	58.5	Sand; residual from granite gneiss; grayish-orange-pink	3.3	9.3
	62.0	Clay; residual from granite gneiss; brown	1.4	14.2
	63.5	Clay; residual from granite gneiss; pink, sandy	1.6	12.6
	64.5	Clay; residual from granite gneiss; grayish-orange-pink	2.6	14.8
	67.0	Clay; residual from granite gneiss; white, sandy	1.6	15.8
	77.0	Clay; residual from granite gneiss; grayish-orange-pink	1.9	12.3

Drill hole logs and assay data of the Stockton deposit—Continued

Formation	Depth (feet)	Description	Available Fe_2O_3	Available Al_2O_3
		Drill hole S–2. Coordinates, 3,200X, 13,500Y		
Tl	3.5	Soil		
	6.0	Clay, transported, light-tan, plastic	1.4	23.0
	10.0	Clay, transported, light-yellow, plastic	0.6	19.6
	20.5	Clay, transported, plastic, limonitic	1.3	17.8
	22.5	Clay, transported, limonitic	6.3	15.5
	23.0	Limonite		
		Drill hole S–3. Coordinates, 3,000X, 13,500Y		
KJg	4.0	Soil		
	7.0	Clay; residual from granite gneiss; light-tan, sandy, slightly plastic.	1.8	17.6
	10.0	Clay; residual from granite gneiss; red, sandy and micaceous.	3.0	15.7
	22.0	Clay; residual from granite gneiss; brown; sandy; contains some weathered feldspar.	1.8	13.0
	25.0	Clay; residual from granite gneiss; some coarse-grained sand.	2.4	11.6
	29.5	Clay; residual from granite gneiss	2.4	13.8
	31.5	Clay; residual from granite gneiss; contains quartz pebbles	0.3	13.7
	35.0	Clay; residual from granite gneiss; sandy	0.4	16.6
		Drill hole S–4. Coordinates, 2,700X, 13,500Y		
Qgl	1.0	Soil and glacial material		
Tl	5.0	Clay, transported, limonitic	0.6	18.4
KJg	6.5	Clay; residual from granite gneiss; brown	1.1	15.5
	10.0	Clay; residual from granite gneiss; white and brown	0.9	15.1
	11.5	Clay; residual from granite gneiss; light yellow	0.3	15.9
	17.0	Clay; residual from granite gneiss; reddish brown; sandy	1.1	17.1
	19.0	Clay; residual from granite gneiss; white and brown	1.1	16.7
	23.0	Clay; residual from granite gneiss; yellowish white	1.6	17.0
	25.5	Clay; residual from granite gneiss; limonitic	3.1	12.3
	30.0	Clay; residual from granite gneiss; brown; sandy	2.0	11.6
		Granite gneiss, semidecomposed		
		Drill hole S–5. Coordinates, 3,000X, 13,000Y		
KJg	3.0	Soil		
	6.5	Clay; residual from granite gneiss	3.4	13.6
	9.5	Clay; residual from granite gneiss; red; sandy; contains semidecomposed feldspar.	4.2	12.8
	12.0	Clay; residual from granite gneiss; red; contains brown streaks.	4.0	10.7
	15.5	Clay; residual from granite gneiss; brown; sandy; contains semidecomposed feldspar.	4.3	12.9
	18.5	Sand; residual from granite gneiss; contains quartz and semidecomposed feldspar.	4.0	11.2
	21.5	Clay; residual from granite gneiss; brown	2.1	15.5
	25.0	Clay; residual from granite gneiss; brown; contains quartz and semidecomposed feldspar.	3.9	15.4
	26.0	Clay; residual from granite gneiss; contains quartz and semidecomposed feldspar.	4.8	14.6
		Granite gneiss semidecomposed		
		Drill hole S–6. Coordinates, 3,500X, 13,000Y		
Tl	4.0	Soil		
	8.0	Clay, transported, light-brown, very hard	2.4	24.5
	22.0	Clay, transported, light-tan, plastic	2.1	18.4
KJg	24.0	Clay; residual from granite gneiss; sandy; limonitic	4.4	9.0
	25.0	Clay; residual from granite gneiss; yellowish-brown	7.6	6.3
	35.0	Clay; residual from granite gneiss; light-gray; sandy	1.8	10.7
	38.0	Clay; residual from granite gneiss; limonitic; micaceous	2.1	9.8

Drill hole logs and assay data of the Stockton deposit—Continued

Formation	Depth (feet)	Description	Available Fe_2O_3	Available Al_2O_3
		Drill hole S–7. Coordinates, 2,600X 13,000Y		
Qb	3.0	Bog deposit		
Tl	5.0	Clay, transported, gray	2.2	13.6
	6.0	Clay, transported, plastic	2.1	20.1
KJg		Granite gneiss		
		Drill hole S–8. Coordinates, 3,400X, 12,500Y		
Tl	0.5	Soil		
	5.0	Clay, transported, light-tan	1.9	23.3
	7.5	Clay, transported, light-purple, very plastic	1.4	25.9
	11.5	Clay, transported, gray, plastic	1.6	23.6
	15.0	Clay, transported, limonitic		
	18.0	Clay, transported, limonitic, contains coarse-grained quarts.	2.2	19.7
		Drill hole S–9. Coordinates, 3,000X, 12,500Y		
KJg	5.5	Soil		
	6.5	Granite gneiss		
		Drill hole S–10. Coordinates, 3,000X, 12,000Y		
KJg	4.0	Soil		
	5.0	Clay; residual from granite gneiss		
		Drill hole S–11. Coordinates, 2,300X, 12,000Y		
Tl	1.0	Soil		
	5.0	Clay, transported, limonitic, sandy		
	6.0	Clay, transported, gray		
KJg	10.0	Clay; residual from granite gneiss; sandy	3.3	16.3
	29.0	Clay; residual from granite gneiss; sandy and micaceous	2.3	15.0
		Drill hole S–12. Coordinates, 3,000X, 11,500Y		
KJg	4.5	Soil		
	6.0	Clay; residual from granite gneiss; red; contains coarse-grained quartz.		
	9.0	Clay; residual from granite gneiss; white; sandy; contains semidecomposed feldspar.		
	12.5	Clay; residual from granite gneiss; brown; sandy; contains semidecomposed feldspar and iron oxide.		
		Drill hole S–13. Coordinates, 3,400X, 11,500Y		
KJg	1.0	Soil		
	8.0	Clay; residual from granite gneiss		
		Drill hole S–14. Coordinates, 2,600X, 11,500Y		
KJg	3.0	Soil		
	5.0	Clay; residual from granite gneiss; contains semidecomposed feldspar.		
		Drill hole S–15. Coordinates, 3,000X, 11,000Y		
KJg	1.0	Soil		
	3.0	Granite gneiss		

Drill hole logs and assay data of the Stockton deposit—Continued

Formation	Depth (feet)	Description	Available Fe_2O_3	Available Al_2O_3
		Drill hole S–16. Coordinates, 3,400X, 11,000Y		
KJg	4.0	Soil		
		Granite gneiss		
		Drill hole S–17. Coordinates, 2,900X, 11,000Y		
Tl	2.0	Soil		
	4.0	Clay, transported		
		Drill hole S–18. Coordinates, 2,500X, 11,000Y		
Tl	3.5	Soil		
	8.0	Clay, transported, purple, hard		
		Drill hole S–19. Coordinates, 3,000X, 18,000Y		
Qb	10.5	Bog deposit		
Tl	16.0	Clay, transported, dark-gray, plastic	1.4	9.3
KJg	25.0	Sand; residual from granite gneiss; coarse-grained		
		Drill hole S–20. Coordinates, 3,300X, 17,500Y		
Qb	5.5	Bog deposit		
Tl	12.5	Clay, transported, light-gray, plastic	1.3	10.4
	14.0	Clay, transported, light-gray, sandy	0.9	16.4
KJg	25.0	Sand, residual from granite gneiss		
		Drill hole S–21. Coordinates, 3,000X, 18,300Y		
Qb	5.5	Bog deposit		
Tl	10.0	Clay, transported, light-gray, plastic	0.6	1.3
	13.25	Clay, transported, light-gray, very hard	2.0	18.4
		Drill hole S–22. Coordinates, 2,800X, 17,000Y		
Qb	7.0	Bog deposit		
Tl	8.0	Clay, transported, light-gray, sandy		
KJg	15.0	Clay; residual from granite gneiss	2.4	9.2
		Drill hole S–23. Coordinates, 3,100X, 16,000Y		
Qb	3.0	Bog deposit		
Tl	4.0	Clay, transported, gray, sandy		
KJg	18.5	Clay; residual from granite gneiss; contains quartz and feldspar.		
		Drill hole S–24. Coordinates, 2,800X, 16,300Y		
Qb	4.0	Bog deposit		
Tl	9.0	Clay, transported, green, plastic	6.2	14.0
	11.0	Clay, transported, coarse-grained; contains quartz and semidecomposed feldspar.	5.2	18.5
		Drill hole S–25. Coordinates, 3,000X, 15,500Y		
Qb	5.5	Bog deposit		
KJg	8.0	Clay; residual from granite gneiss; reddish-brown		
	11.5	Clay; residual from granite gneiss; grayish orange-pink, micaceous.		
	12.5	Clay; residual from granite gneiss; brown, limonitic, sandy.		

Drill hole logs and assay data of the Stockton deposit—Continued

Formation	Depth (feet)	Description	Available Fe_2O_3	Available Al_2O_3
		Drill hole S-26. Coordinates, 3,100X, 15,500Y		
KJg	1.5	Soil		
	8.0	Clay; residual from granite gneiss; red; micaceous; sandy	0.6	2.7
	11.0	Clay; residual from granite gneiss; grayish orange-pink	1.6	15.4
	19.0	Clay; residual from granite gneiss; red	2.1	18.1
	20.0	Clay; residual from granite gneiss; brown	2.1	15.5
	25.0	Clay; residual from granite gneiss; pink and white	1.0	14.0
	36.0	Clay; residual from granite gneiss; white; sandy and micaceous.	0.6	13.2
	41.0	----do----	1.3	7.1
		Drill hole S-27. Coordinates, 3,000X, 15,100Y		
KJg	2.0	Soil		
	5.0	Clay; residual from granite gneiss; sandy; limonitic		
	8.0	Clay; residual from granite gneiss; gray; sandy		
	23.0	Clay; residual from granite gneiss; gray; sandy; contains brown streaks.		
	25.0	Clay; residual from granite gneiss; coarse-grained; sandy; contains semidecomposed feldspars.		
		Drill hole S-28. Coordinates, 2,800X, 15,000Y		
Qgl	4.0	Soil and glacial material		
KJg	9.0	Clay; residual from granite gneiss; micaceous; contains coarse-grained sand.		
	10.0	Clay; residual from granite gneiss; sandy; contains semi-decomposed feldspar.		
		Drill hole S-29. Coordinates, 3,600X, 17,300Y		
Qgl	0.5	Soil and glacial material		
Tl	5.0	Clay, transported, light-tan, hard	1.0	3.4
	10.0	Clay, transported, light-gray, hard	0.4	9.2
	14.0	Clay, transported, gray-brown, plastic, soft	1.1	3.7
	14.5	Clay, transported, limonitic		
		Drill hole S-30. Coordinates, 3,500X, 17,000Y		
Qgl	5.0	Soil		
	10.0	Glacial sand and pebbles		
KJg	15.0	Sand; residual from granite gneiss; micaceous	1.5	9.6
		Drill hole S-31. Coordinates, 3,560X, 17,500Y		
Tl	1.0	Soil		
	5.0	Clay, transported, white, plastic	2.0	10.1
	10.0	Clay, transported, light-tan, plastic	2.0	10.8
	15.0	Clay, transported, tan, plastic	1.7	8.9
	20.0	Clay, transported, light-brown, plastic	1.7	10.5
	25.0	Clay, transported, reddish-brown, plastic	2.0	16.9
	30.0	Clay, transported, limonitic, plastic	2.0	8.6
		Drill hole S-32. Coordinates, 3,600X, 17,700Y		
Tl	0.5	Soil		
	20.5	Clay, transported, gray, plastic	1.3	17.0
	23.5	Clay, transported, light-gray, plastic	1.5	16.8
	25.0	Clay, transported, dark-gray, plastic	1.7	18.4
	31.5	Clay, transported, light-brown, limonitic	3.6	10.5

Drill hole logs and assay data of the Stockton deposit—Continued

Formation	Depth (feet)	Description	Available Fe_2O_3	Available Al_2O_3
		Drill hole S–33. Coordinates, 2,700X, 18,000Y		
Qgl	5.0	Glacial material		
Tl	6.0	Clay and gravel, transported		
KJg	8.0	Granite gneiss, semidecomposed		
		Drill hole S–34. Coordinates, 3,000X, 17,500Y		
Qb	5.0	Bog deposit		
	6.0	Clay, transported, gray; and coarse-grained sand		
KJg	8.0	Sand; residual from granite gneiss; coarse-grained		
		Drill hole S–35. Coordinates 3,100X, 17,500Y		
Qb	5.0	Bog deposit		
Tl	6.0	Clay, transported, gray, and coarse-grained sand		
KJg	8.0	Sand; residual from granite gneiss; coarse-grained		
		Drill hole S–36. Coordinates 3,000X, 17,000Y		
Qb	5.0	Bog deposit		
KJg	6.0	Gravel; residual from granite gneiss; coarse-grained		
		Drill hole S–37. Coordinates 3,400X, 17,000Y		
Qb	4.0	Soil and basalt float		
		Drill hole S–38. Coordinates 3,000X, 16,500Y		
Qb	5.1	Soil and basalt float		
		Drill hole S–39. Coordinates 3,100X, 16,500Y		
Qb	3.0	Bog deposit		
		Drill hole S–40. Coordinates 3,200X, 16,500Y		
Qb	3.0	Bog deposit		
		Drill hole S–41. Coordinates 3,300X, 16,500Y		
Qb	3.0	Bog deposit		
		Drill hole S–42. Coordinates 3,000X, 16,300Y		
Qb	3.0	Bog deposit		
		Drill hole S–43. Coordinates 3,655X, 17,500Y		
Tl	4.0	Soil		
	8.0	Clay, transported, tan		
	16.0	Clay, transported, hard		

Drill hole logs and assay data of the Stockton deposit—Continued

Formation	Depth (feet)	Description	Available Fe_2O_3	Available Al_2O_3
		Drill hole S-44. Coordinates 3,635X, 17,600Y		
Tl	6.0	Soil		
	11.0	Clay, transported, gray, slightly plastic	4.8	8.1
	15.0	Clay, transported, limonitic, slightly plastic	5.7	5.3
	20.0	Clay, transported, gray, brown-streaked, plastic	2.1	10.9
	25.0	Clay, transported, bluish-gray, plastic	1.7	12.6
	29.5	Clay, transported, bluish-gray and brown, plastic	4.7	12.5
		Drill hole S-45. Coordinates 5,100X, 13,900Y		
Tl	4.0	Soil		
	9.0	Clay, transported, gray, plastic	2.5	26.1
	14.0	Clay, transported, reddish-brown, plastic	5.1	21.3
	18.0	Clay, transported, gray and brown, micaceous, plastic	3.8	22.6
	23.0	Clay, transported, light-gray, plastic	2.9	24.6
	28.0	Clay, transported, light-gray, micaceous, plastic	2.4	22.4
	31.0	Clay, transported, reddish-brown, sandy	10.9	14.8
		Drill hole S-46. Coordinates 5,100X, 14,000Y		
Qg	5.5	Glacial material		
Tl	8.0	Clay, transported, grayish-black	3.4	5.5
	18.0	Clay, transported, grayish-brown, plastic	3.0	21.6
	28.0	Clay, transported, reddish-brown, plastic	5.3	20.4
	40.0	Clay, transported, light-gray, plastic	5.9	22.7
	41.0	Limonite		
		Drill hole S-47. Coordinates 3,200X, 18,000Y		
Qb	15.0	Bog deposit		
		Drill hole S-48. Coordinates, 5,300X, 13,500Y		
Qg	7.0	Soil and glacial material		
Tl	15.0	Clay, transported, gray and brown, sandy	5.3	15.4
	20.0	Clay, transported, gray and brown, micaceous and sandy	3.2	15.1
	25.0	Clay, transported, dark-brown, micaceous and sandy	5.1	10.2
	40.0	Clay, transported, light-brown, micaceous and sandy	2.0	6.1
		Drill hole S-49. Coordinates 4,800X, 14,300Y		
Qg	3.0	Soil		
	6.0	Glacial till		
Tl	7.0	Sand, transported; cemented by limonite		
Tc	11.0	Clay; residual from basalt; blue-black; contains tan bidellite.		
	15.0	Clay; residual from basalt; contains yellow bands of limonite.		
	20.0	Clay; residual from basalt; blue; limonite	12.9	25.2
		Drill hole S-50. Coordinates 3,500X, 13,500Y		
Tl	5.0	Soil		
	10.0	Clay, transported, light tan		
	15.0	Clay, transported, iron-stained		
	30.0	Clay, transported, plastic		
		Drill hole S-51. Coordinates 3,465X, 13,600Y		
Tl	3.5	Soil		
	7.0	Clay, transported, light gray, plastic		
	8.0	Sand, transported		
	20.5	Clay, transported, plastic		

Drill hole logs and assay data of the Stockton deposit—Continued

Formation	Depth (feet)	Description	Available Fe_2O_3	Available Al_2O_3
		Drill hole S–52. Coordinates, 3,300X, 13,500Y		
Tl	2.0	Soil		
	7.0	Clay, transported, plastic		
	19.0	Clay, transported, purple, plastic		
		Drill hole S–53. Coordinates, 3,700X, 14,000Y		
Qb	2.0	Bog deposit		
		Drill hole S–54. Coordinates 3,700X, 14,100Y		
Qb	2.0	Bog deposit		
		Drill hole S–55. Coordinates 3,800X, 14,100Y		
Qb	2.0	Bog deposit		
		Drill hole S–56. Coordinates 3,700X, 13,900Y		
Qb	2.0	Bog deposit		
		Drill hole S–57. Coordinates, 3,800X, 13,900Y		
Qb	4.0	Bog deposit		
		Drill hole S–58. Coordinates, 3,600X, 13,900Y		
Qb	3.0	Bog deposit		
		Drill hole S–59. Coordinates, 3,500X, 13,900Y		
Qb	1.0	Bog deposit		
		Drill hole S–60. Coordinates, 3,400X, 13,900Y		
Tcu	2.0	Soil and basalt		
		Drill hole S–61. Coordinates, 3,500X, 13,800Y		
Qb	4.0	Bog deposit		
		Drill hole S–62. Coordinates, 3,300X, 13,800Y		
Tcu	3.0	Soil and basalt		
		Drill hole S–64. Coordinates, 3,700X, 13,800Y		
Qb	5.0	Bog deposit		
		Drill hole S–65. Coordinates, 3,700X, 13,700Y		
Qb	5.0	Bog deposit		

Drill hole logs and assay data of the Stockton deposit—Continued

Formation	Depth (feet)	Description	Available Fe_2O_3	Available Al_2O_3
		Drill hole S–66. Coordinates, 3,800X, 13,700Y		
Tcu	3.0	Soil and basalt		
		Drill hole S–67. Coordinates, 3,600X, 13,700Y		
Qb	2.0	Bog deposit		
		Drill hole S–68. Coordinates, 3,500X, 13,700Y		
Tcu	0.5	Soil and basalt		
		Drill hole S–69. Coordinates, 3,400X, 13,700Y		
Tl	2.0			
		Drill hole S–70. Coordinates, 4,900X, 14,000Y		
Qg	9.0	Glacial material and basalt float		
		Drill hole S–71. Coordinates, 3,200X, 14,000Y		
Tl	2.0	Soil		
	7.0	Clay, transported, gray, sandy, plastic		
	12.0	Clay, transported, light-gray, plastic		
	13.0	Clay, transported, gray-purple, plastic		
	18.0	Clay, transported, gray and brown streaked, plastic		
	33.0	Clay, transported, bluish-gray, plastic		
	36.0	Clay, transported, gray		
		Drill hole S–72. Coordinates, 3,300X, 14,000Y		
Tcu	2.0	Soil and basalt		
		Drill hole S–73. Coordinates, 3,000X, 14,000Y		
Tcu	3.0	Soil and basalt		
		Drill hole S–74. Coordinates, 2,800X, 14,000Y		
Qg	1.0	Glacial material		
		Drill hole S–75. Coordinates, 2,700X, 14,000Y		
Qg	3.0	Glacial material		
		Drill hole S–76. Coordinates, 2,600X, 14,000Y		
Qg	6.0	Glacial material		
		Drill hole S–77. Coordinates, 4,900X, 14,100Y		
Qg	2.0	Glacial material		

Drill hole logs and assay data of the Stockton deposit—Continued

Formation	Depth (feet)	Description	Available Fe_2O_3	Available Al_2O_3
		Drill hole S-78. Coordinates, 4,900X, 14,200Y		
Qg	2.0	Glacial material		
		Drill hole S-79. Coordinates, 4,900X, 14,300Y		
Qg	1.0	Glacial material		
		Drill hole S-80. Coordinates, 4,900X, 14,400Y		
Tcu	2.0	Soil and basalt		
		Drill hole S-81. Coordinates, 5,000X, 14,100Y		
Qg	1.0	Glacial material		
		Drill hole S-82. Coordinates, 5,000X, 14,200Y		
Qg	2.0	Glacial material		
		Drill hole S-83. Coordinates, 5,000X, 14,300Y		
Tcu	2.0	Soil and basalt		
		Drill hole S-84. Coordinates, 5,000X, 14,400Y		
Tcu	3.0	Soil and basalt		
		Drill hole S-85. Coordinates, 5,000X, 14,500Y		
Tcu	2.0	Soil and basalt		
		Drill hole S-86. Coordinates, 5,100X, 14,100Y		
Tcu	2.0	Soil and basalt		
		Drill hole S-87. Coordinates, 5,100X, 14,200Y		
Tcu	3.0	Soil and basalt		
		Drill hole S-88. Coordinates, 5,100X, 14,300Y		
Tcu	2.0	Soil and basalt		
		Drill hole S-89. Coordinates, 5,100X, 14,400Y		
Tcu	1.0	Soil and basalt		
		Drill hole S-90. Coordinates, 5,100X, 14,500Y		
Tcu	2.0	Soil and basalt		

Drill hole logs and assay data of the Stockton deposit—Continued

Formation	Depth (feet)	Description	Available Fe_2O_3	Available Al_2O_3
		Drill hole S-91. Coordinates, 5,100X, 14,600Y		
Tcu	3.0	Soil and basalt		
		Drill hole S-92. Coordinates, 5,000X, 13,900Y		
Tcu	2.0	Soil and basalt		
		Drill hole S-93. Coordinates, 5,000X, 13,800Y		
Tcu	3.0	Soil and basalt		
		Drill hole S-94. Coordinates, 5,000X, 13,700Y		
Tcu	2.0	Soil and basalt		
		Drill hole S-95. Coordinates, 5,000X, 13,600Y		
Tcu	1.0	Soil and basalt		
		Drill hole S-96. Coordinates, 5,000X, 13,500Y		
Tcu	3.0	Soil and basalt		
		Drill hole S-97. Coordinates, 2,900X, 14,000Y		
Qg	2.5	Glacial material		
KJg	7.0	Clay, residual from granite gneiss, pink, micaceous		
	17.0	Clay, residual from granite gneiss, brown		
		Drill hole S-98. Coordinates, 5,800X, 14,600Y		
Qt	3.0	Talus		
Tl	10.0	Clay, transported, gray, limonite-streaked		
	11.0	Limonite		
	14.0	Clay, transported, limonitic		
	15.0	Clay, transported, dark brown, limonitic		
	19.0	Clay, transported, gray, limonite-stained		
	19.2	Limonite		
	24.0	Clay, transported, gray, micaceous		
	30.5	Clay, transported, gray, limonite-streaked		
	39.0	Clay, transported, gray		
	40.0	Clay, transported, gray, micaceous, limonite-streaked		
		Drill hole S-99. Coordinates, 3,100X, 15,400Y		
Tl	1.0	Soil		
	5.0	Clay, transported		
	10.0	Clay, transported, light gray		
KJg	14.0	Clay, residual from granite gneiss, dark gray		
	20.0	Clay, residual from granite gneiss, dark brown		
	44.2	Clay, residual from granite gneiss, pink		
		Drill hole S-100. Coordinates, 3,200X, 15,400Y		
Tl	6.0	Soil		
	11.0	Clay, transported, sandy		
	16.0	Clay, transported, gray		
KJg	21.0	Clay, residual from granite gneiss, brown, sandy		

Drill hole logs and assay data of the Stockton deposit—Continued

Formation	Depth (feet)	Description	Available Fe_2O_3	Available Al_2O_3
		Drill hole S–101. Coordinates, 3,200X, 15,700Y		
KJg	6.0	Soil, sandy		
	11.0	Clay, residual from granite gneiss, pink and brown		
	30.0	Clay, residual from granite gneiss, brown, sandy and micaceous.		
		Drill hole S–102. Coordinates, 3,000X, 15,700Y		
Qb	4.0	Bog deposit		
KJg	10.0	Clay, residual from granite gneiss, sandy, limonitic		
	15.0	Clay, residual from granite gneiss, sandy		
		Drill hole S–103. Coordinates, 3,000X, 14,500Y		
KJg	2.0	Soil		
	7.0	Clay, residual from granite gneiss, gray, micaceous		
		Drill hole S–104. Coordinates, 2,900X, 14,500Y		
Qb	1.0	Bog deposit		
KJg	4.2	Clay, residual from granite gneiss, gray, sandy		
	13.0	Clay, residual from granite gneiss, tan, micaceous, sandy, semi-decomposed feldspar.		
		Drill hole S–105. Coordinates, 3,200X, 16,000Y		
Qb	4.0	Bog deposit		
Tl	9.0	Clay, transported		
KJg	10.0	Clay, residual from granite gneiss		
		Drill hole S–106. Coordinates, 3,800X, 13,000Y		
Tcu	1.0	Soil		
	4.0	Semi-decomposed basalt		
	5.0	Clay, residual from basalt		
		Drill hole S–107. Coordinates, 3,800X, 13,100Y		
Tcu	4.0	Soil and basalt		
		Drill hole S–108. Coordinates, 5,100X, 13,700Y		
Qg	2.5	Glacial material		
Tl	4.0	Clay, transported, grayish, purple		
		Drill hole S–109. Coordinates, 3,600X, 13,200Y		
Tl	3.0	Soil and clay, transported		
		Drill hole S–110. Coordinates, 3,600X, 13,100Y		
Tl	2.0	Soil and clay, transported		
		Drill hole S–111. Coordinates, 3,700X, 12,900Y		
Tl	3.5	Soil and clay, transported		

Drill hole logs and assay data of the Stockton deposit—Continued

Formation	Depth (feet)	Description	Available Fe_2O_3	Available Al_2O_3
		Drill hole S–112. Coordinates, 3,800X, 12,900Y		
Tcu	3.5	Soil and basalt		
		Drill hole S–113. Coordinates, 5,800X, 14,300Y		
Qt	9.0	Talus		
		Drill hole S–114. Coordinates, 5,840X, 14,800Y		
Qt	8.0	Talus		
		Drill hole S–115. Coordinates, 5,260X, 13,480Y		
Qt-Tl	15.0	Clay, transported, gray		
KJg	18.0	Clay, residual from granite gneiss, coarse-grained sand		
		Drill hole S–116. Coordinates, 5,320X, 13,650Y		
Qt	2.0	Soil and talus		
KJg	7.0	Clay, residual from granite gneiss, coarse-grained sand		
	11.0	Sand, residual from granite gneiss, coarse-grained semi-decomposed gneiss.		
		Drill hole S–117. Coordinates, 5,350X, 13,650Y		
Qt	5.0	Soil and talus		
Tl	10.0	Clay, transported, gray, sandy		
	14.0	Sand, transported, brown		
		Drill hole S–118. Coordinates, 5,560X, 13,370Y		
Qt	6.0	Soil and talus		
Tl	11.0	Clay, transported, brown, sandy		
		Drill hole S–119. Coordinates, 5,800X, 14,420Y		
Qt	5.0	Soil and talus		
Tl	8.5	Clay, transported, gray, very hard		
	10.0	Clay, transported, brown, limonite-streaked, plastic		
	15.0	Clay, transported, brown, sandy		
	20.0	Clay, transported, light brown, sandy		
	25.0	Clay, transported, light brown, micaceous, sandy		
		Drill hole S–120. Coordinates, 4,500X, 16,000Y		
Qb	7.0	Bog deposit		
Tl	15.0	Clay, transported, plastic		
		Drill hole S–121. Coordinates, 3,800X, 15,100Y		
Qb	2.0	Bog deposit		
		Drill hole S–122. Coordinates, 3,800X, 15,000Y		
Qb	3.0	Bog deposit		

Drill hole logs and assay data of the Stockton deposit—Continued

Formation	Depth (feet)	Description	Available Fe_2O_3	Available Al_2O_3
		Drill hole S–123. Coordinates, 3,800X, 14,900Y		
Qb	2.0	Bog deposit		
		Drill hole S–124. Coordinates, 3,800X, 14,800Y		
Qb	3.0	Bog deposit		
		Drill hole S–125. Coordinates, 3,900X, 14,900Y		
Qb	1.0	Bog deposit		
		Drill hole S–126. Coordinates, 4,000X, 14,900Y		
Qg	2.0	Glacial material		
		Drill hole S–127. Coordinates 4,100X, 14,900Y		
Qg	3.0	Glacial material		
		Drill hole S–128. Coordinates 3,900X, 14,800Y		
Qg	1.0	Glacial material		
		Drill hole S–129. Coordinates 3,700X, 14,900Y		
Qb	8.0	Bog deposit		
		Drill hole S–130. Coordinates 4,600X, 15,500Y		
Qg	4.0	Glacial material		
		Drill hole S–131. Coordinates 4,600X, 15,400Y		
Tcu	3.0	Soil and basalt		
		Drill hole S–132. Coordinates 4,600X, 15,600Y		
Qg	2.0	Glacial material		
		Drill hole S–133. Coordinates 4,600X, 15,700Y		
Qg	5.0	Glacial material		
		Drill hole S–134. Coordinates 4,700X, 15,600Y		
Qb	3.0	Bog deposit		
		Drill hole S–135. Coordinates 4,800X, 15,600Y		
Qb	1.0	Bog deposit		

Drill hole logs and assay data of the Stockton deposit—Continued

Formation	Depth (feet)	Description	Available Fe_2O_3	Available Al_2O_3
		Drill hole S-136. Coordinates 4,900X, 15,600Y		
Qb	3.0	Bog deposit		
		Drill hole S-137. Coordinates 5,000X, 15,600Y		
Tcu	3.0	Soil and basalt		
		Drill hole S-138. Coordinates 5,100X, 15,600Y		
Tcu	4.0	Soil and basalt		
		Drill hole S-139. Coordinates 5,100X, 15,500Y		
Qb	2.0	Bog deposit		
		Drill hole S-140. Coordinates 5,100X, 15,400Y		
Qb	3.0	Bog deposit		
		Drill hole S-141. Coordinates 5,000X, 15,400Y		
Qb	6.0	Bog deposit		
		Drill hole S-142. Coordinates 4,900X, 15,400Y		
Qb	2.0	Bog deposit		
		Drill hole S-143. Coordinates 4,800X, 15,400Y		
Tcu	2.5	Soil and basalt		
		Drill hole S-144. Coordinates 4,700X, 15,400Y		
Qb	1.5	Bog deposit		
		Drill hole S-145. Coordinates 3,700X, 17,100Y		
Qg	6.0	Glacial material		
		Drill hole S-146. Coordinates 3,800X, 17,100Y		
Qg	5.2	Glacial material		
Tl	15.2	Clay, transported, dark and light gray		
	20.0	Clay, transported, brown and gray		
KJg	21.5	Sand, residual from granite gneiss		
		Drill hole S-147. Coordinates 3,900X, 17,180Y		
Qg	5.5	Glacial material		
		Drill hole S-148. Coordinates 4,000X, 17,265Y		
Qg	4.5	Glacial material		

Drill hole logs and assay data of the Stockton deposit—Continued

Formation	Depth (feet)	Description	Available Fe_2O_3	Available Al_2O_3
		Drill hole S–149. Coordinates, 4,100X, 17,300Y		
Qg	5.0	Glacial material		
		Drill hole S–150. Coordinates, 4,225X, 17,375Y		
Qg	5.0	Glacial material		
		Drill hole S–151. Coordinates, 4,290X, 17,250Y		
Qg	6.0	Glacial material		
		Drill hole S–152. Coordinates, 5,000X, 16,450Y		
Qb	4.5	Bog deposit		
		Drill hole S–153. Coordinates, 3,100X, 17,000Y		
Qb	3.5	Bog deposit		
		Drill hole S–154. Coordinates, 3,200X, 17,000Y		
Qb	3.0	Bog deposit		
		Drill hole S–155. Coordinates, 3,300X, 17,000Y		
Qb	4.0	Bog deposit		
		Drill hole S–156. Coordinates, 5,000X, 14,900Y		
Qg	5.5	Glacial material		
		Drill hole S–157. Coordinates, 4,900X, 14,900Y		
Qb	3.0	Bog deposit		
		Drill hole S–158. Coordinates, 4,800X, 14,900Y		
Qb	4.0	Bog deposit		
		Drill hole S–159. Coordinates, 4,800X, 15,000Y		
Tcu	2.5	Soil and basalt		
		Drill hole S–160. Coordinates, 4,800X, 14,800Y		
Tcu	2.0	Soil and basalt		

Drill hole logs and assay data of the Stockton deposit—Continued

Formation	Depth (feet)	Description	Available Fe_2O_3	Available Al_2O_3
		Drill hole S–161. Coordinates, 4,700X, 14,900Y		
Qb	3.25	Bog deposit		
		Drill hole S–162. Coordinates, 4,600X, 14,900Y		
Qb	5.0	Bog deposit		
		Drill hole S–163. Coordinates, 4,500X, 14,900Y		
Qg	4.7	Glacial material		

Drill hole logs and assay data of the Elk River deposit

Formation	Depth (feet)	Description	Ignition loss	Available Al_2O_3	Available Fe_2O_3
		Drill hole ER–1. Location, SW¼, SE¼, sec. 34, T. 40 N., R. 2 E., Boise meridian, elevation, 3,048 feet			
Tcm	2.4	Soil			
	7.4	Basalt, blue-green, semi-decomposed	6.3	12.8	11.6
	12.4	Basalt, blue-green, semi-decomposed			
	14.0	Basalt, blue-green, semi-decomposed	4.9	9.0	11.0
		Drill hole ER–2. Location, SE¼, NE¼, sec. 3, T. 39 N., R. 2 W., Boise meridian, elevation, 3,152 feet			
Tlu	2.5	Soil			
	7.5	Clay, transported, yellow and brown	9.6	23.6	2.6
	12.5	Clay, transported, pink, plastic	11.3	29.7	1.3
	22.5	Clay, transported, brown, plastic	13.4	29.1	1.3
	41.0	Clay, transported, brown and blue-gray	13.0	26.0	2.4
	47.7	Clay, transported, yellow, plastic	8.7	24.6	5.0
		Drill hole ER–3. Location, NW¼, SE¼, sec. 34, T. 40 N., R. 2 E., Boise meridian, elevation, 3,010 feet			
Tll	1.1	Soil			
	6.1	Clay, transported, red, sandy			
	10.1	Clay, transported, yellow, sandy; streaked by hematite	6.5	14.3	15.3
	14.3	Clay, transported, yellow, sandy			
Tcl	19.3	Clay; residual from basalt; gray and brown			
	24.3	Clay; residual from basalt; gray	4.6	12.6	4.1
	29.3	Clay; residual from basalt; yellow and gray			
	33.0	lay; residual from basalt; red	3.5	9.2	7.2
	34.3	Clay; residual from basalt; brown			

Drill hole logs and assay data of the Camas Prairie deposits

Formation	Depth (feet)	Description	Ignition loss	Available Al_2O_3	Available Fe_2O_3
Drill hole CP–1. Location, middle of sec. 31, T. 30 N., R. 2 E., Boise meridian, elevation, 3,340 feet					
Tl	2.0	Soil, black, sticky			
	6.0	Gravel, transported, coarse-grained, clayey	.0	8.4	12.2
Drill hole CP–2. Location, SE¼, SW¼, sec. 29, T. 30 N., R. 3 E., Boise meridian, elevation, 3,685 feet					
Tl	0.5	Soil			
	5.5	Clay, transported, red, plastic; white spots	12.5	6.5	32.0
	8.5	do	12.4	8.1	33.5
	13.5	do	12.2	10.8	33.8
	18.5	do	12.6	9.3	33.8
	21.5	Clay, transported, white, brown-stained	13.0	6.6	34.9
	28.5	Clay, transported, pink-gray, plastic	12.8	3.7	33.4
Drill hole CP–3. Location, NE¼, NW¼, sec. 35, T. 30 N., R. 2 E., Boise meridian, elevation, 3,540 feet					
Tl	4.0	Clay, transported, gray	13.1	2.6	31.3
	8.5	Clay, transported, gray, brown-stained	11.9	2.7	32.4
	10.3	do	11.6	7.0	30.2
	11.6	Clay, transported, yellow	11.2	6.1	28.8
Tc		Basalt, hard			
Drill hole CP–4. Location, W½, SE¼, sec. 31, T. 30 N., R. 2 E., Boise meridian, elevation, 3,360 feet[1]					
Tl	12.0	Soil			
	18.5	Clay, transported, gray plastic	12.4	2.5	32.8
	23.0	Clay, transported, gray, brown-stained, plastic	12.3	3.4	32.6
	28.5	Clay, transported, light brown	11.3	3.9	28.5
	33.5	Clay, transported, brown-stained	8.7	3.7	21.9
	35.0	Sand and gravel, transported, quartz, brown	4.8	4.8	11.6

[1] Previously drilled by Mr. Guy Sherwin.

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